Video Display, D-VNC15 (Rev 00)

LCD Display, D-LCC10 (Rev. 03)

VGA Display Controller, B-DVGA (Rev. 03)

Display Controller, B-DISP (Rev. 00)

Command Board, K-VNC15 (Rev. 00)

All specifications subject to change without notice

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Table of Contents

GENERAL DESCRIPTION 1

1 SPECIFICATIONS 2

1.1 General Specifications 2
1.2 Typical Performance 2
1.3 Technical Specification 4

2 FUNCTIONAL DESCRIPTION 5

2.1 Measurement Principle 5
2.1.1 $CO_2/N_2O/AA$ Measurement 5
2.1.2. O_2 Measurement 6
2.1.3 Agent Identification 7
2.1.4 Side Stream Spirometry 8
2.2 Main Components and Block Diagrams 10
2.2.1 In General 10
2.2.2 Gas Sampling System 12
2.2.3 ACX-200 Measuring Unit 18
2.2.4 O_2 Measurement 21
2.2.5 ACX Measuring Board 22
2.2.6 ASX Agent Identification Bench 24
2.2.7 ASX Measuring Board 25
2.2.8 PVX Board 27
2.2.9 Gas Mother Board 29
2.2.10 Gas Interface Board 32
2.3 Connectors and Signals 33

3 SERVICE PROCEDURES 38

3.1 General Service Information 38
3.2 Preventive Maintenance 39
3.3 Disassembly and Reassembly 41
3.4 Adjustments and Calibrations 43
3.4.1 Gas Sampling System Adjustment 43
3.4.2 Oxygen Measurement Unit Adjustments 46
3.3.3 Flow Calibration 48

4 TROUBLESHOOTING 50

4.1 General Troubleshooting Chart 50
4.2 Gas Sampling System Troubleshooting 53
4.3 O_2 Measurement Troubleshooting 55
4.4 ACX Troubleshooting 56
4.5 ASX Troubleshooting 57

4.6 PVX Board troubleshooting 58
4.7 Gas Mother Board Troubleshooting 59
4.8 Error Messages 60

5 SERVICE VIEW **62**

5.1 Gas Mother Board 63
5.2 ACX Service menu 67
5.3 PVX Service Menu 70
5.4 ASX Service Menu 74

6 SPARE PARTS **76**

6.1 Spare parts list 76

7 EARLIER REVISIONS **80**

INTRODUCTION

This section provides information about the maintenance and service of the LCD display (D-LCC10), the Display controller boards (B-DISP, B-DVGA, B-DHIGH), and the Command Boards (K-VNC15, K-VHC14) of the Anaesthesia and Compact Monitors.

Notice that the service information of D-VNC15 (D-VHC14) are delivered on request.

NOTE: The backlight circuit runs on a high voltage. Do not touch the adapter board when powered.

1 SPECIFICATIONS

1.1 LCD Display, D-LCC10

Display size	10.4 in
Display type	Active Matrix 8-colour LCD Display
Resolution	640 x 480 x (R,G,B)

DIMENSIONS

Outline (ComWheel™ included) (W x D x H)	315 x 74 x 265.5 mm / 12.4 x 2.9 x 10.5 in
Weight	3.5 kg / 7.7 lb

ELECTRICAL REQUIREMENTS

LCD Display, D-LCC10 rev.03, can only be used connected to B-DVGA rev. 03 or B-DISP Display controller boards in the Anaesthesia Monitor.

Power consumption	10 W

ENVIRONMENTAL REQUIREMENTS

Operating temperature	10-35°C / 50-95°F
Storage temperature	-10-50°C / 14-122°F
Atmospheric pressure	500-800 mmHg (660-1060 mbar)
Humidity	0-85 % non-condensing

1.2 Display Controller Board, B-DISP

Video output: both connectors and both resolutions, analog RGB, 0.2V - 1.1V, 0,8 V_{pp}, 75 ohm

Output data, B-DISP, High resolution

Resolution: horizontal 1984 pixels, vertical 512 pixels
Frame frequency: 65 Hz
Scan frequency: 34,7 kHz
Dot frequency: 80 MHz max.
Sync polarity: H/negative, V/negative, level TTL
Sync pulse:

	Horizontal	Vertical
Front porch	1.125 us	0.037 ms
Sync period	3.000 us	0.073 ms
Back porch	1.375 us	0.442 ms

Output data, B-DISP, VGA resolution

Resolution: horizontal 640 pixels, vertical 480 pixels
Frame frequency: 60 Hz
Scan frequency: 31.6 kHz
Dot frequency: 25 MHz max.
Sync polarity: H/negative, V/negative, level TTL
Sync pulse:

	Horizontal	Vertical
Front porch	0.640 us	0.349 ms
Sync period	3.520 us	0.063 ms
Back porch	1.920 us	1.019 ms

1.3 Display Controller Board, B-DVGA (B-DHIGH)

Output data, B-DVGA

Video output: 15-pin D-connector: analog RGB, 0.45 V - 1.25 V, 75 ohm. 26-pin D-connector: analog RGB, 0.45 - 1.25 V
Resolution: horizontal 640 pixels, vertical 480 pixels
Frame frequency: 60.125 Hz
Scan frequency: 31.566 kHz
Dot frequency: 25 MHz max.
Sync polarity: H/negative, V/negative, level TTL
Sync pulse:

	Horizontal	Vertical
Front porch	0.640 us	0.349 ms
Sync period	3.520 us	0.063 ms
Back porch	1.920 us	1.019 ms

Output data, B-DHIGH

Video output: both connectors, analog RGB, 0.45 V - 1.25 V, 75 ohm

Resolution: horizontal 1984 pixels, vertical 512 pixels
Frame frequency: 51.987 Hz
Scan frequency: 27.397 kHz
Dot frequency: 32 MHz max.
Sync polarity: H/negative, V/negative, level TTL
Sync pulse:

	Horizontal	Vertical
Front porch	1.125 us	0.037 ms
Sync period	3.000 us	0.073 ms
Back porch	1.375 us	0.442 ms

1.4 Command Board, K-VNC15 (K-VHC14)

Dimensions	
Input voltage	5 V
Power consumption	
Communication protocol	RS-232

NOTE: Power supply from the display controller board only.

2 FUNCTIONAL DESCRIPTION

2.1 LCD Display

LCD Display, D-LCC10 includes LCD Display module, LCD Interface board, and Command Board with keyboard.

The keyboard works independent of the main keyboard of AS/3 monitor.

The LCD Display is connected to B-DVGA or B-DISP Display controller board in the monitor frame with the LCD Display interface cable. The interface cable is available as an accessory. See AS/3 Anaesthesia Monitor Supplies and Accessories Catalogue.

Communication between the Display controller board and the LCD Display takes place in analog form (in 00-02 revisions it was in digital form). Incoming signals are buffered in the interface board and fed forward to the LCD Display module.

Communication between the Display controller board and the Command Board takes place in RS232 serial communication channel D.

NOTE: B-DVGA rev. 01 and rev. 02 do not support D-LCC10-XX-03. D-LCC10-XX-03 requires B-DVGA rev. 03 or B-DISP.

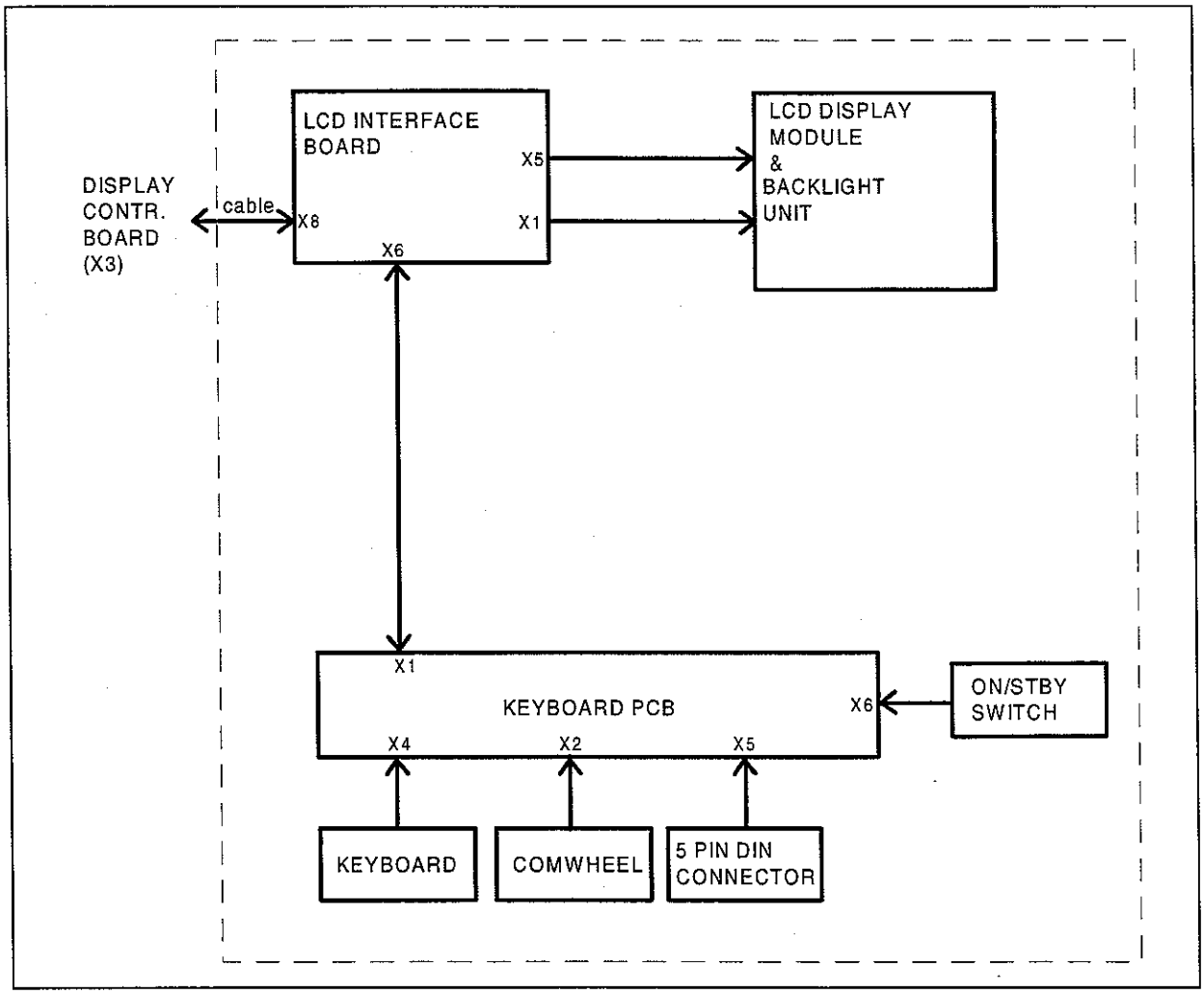


Figure 1 General Block Diagram

2.1.1 LCD Interface Board

In general

The LCD Interface board is the interface between the Display controller board and the LCD Display component. The keyboard is also connected to the Interface board. (See Figure 1)

The incoming signal to LCD Interface board is pure analog VGA - RGB with separate horizontal and vertical synchronisation signals. (See Figure 2) The display element needs digital RGB-signals, HSYNC, VSYNC, DOTCLK and a display timing signal DTMG. The DTMG signal indicates that the digital RGB-signals are active.

The functions of this board are digitalization of the video signals, regeneration of the DOTCLK and generation of the DTMG. The backlight driver is also located on the board.

Power Supply

The DC/DC power supply is an isolated discontinuous mode flyback switcher. It has a current mode PWM circuit and a separate FET switch on the primary side. The transformer has two secondary windings, one for 5V and another for 12V. On the secondary side (5V), there is a separate chip on the feedback path to drive the optoisolator.

Backlight Unit

The backlight unit is integrated to the LCD Display component. The backlight consists of one Cold Cathode Fluorescent Lamp (CCFL), which runs on a high AC voltage. The lamp needs approximately 1400 Volts to lit, but runs on a lower (500-600) voltage when on.

The backlight unit is an irreparable part, therefore only the whole LCD Display component can be replaced. If there is need to replace the LCD Display component please note: that the LCD Display is very sensitive for mistreatment. The service instructions (in Chapter 3) should be followed carefully when handling the component.

NOTE: The LCD Display component and Backlight unit are separate units in the D-LCC10, revision 01 and 02, therefore the units are possible to be replaced separately.

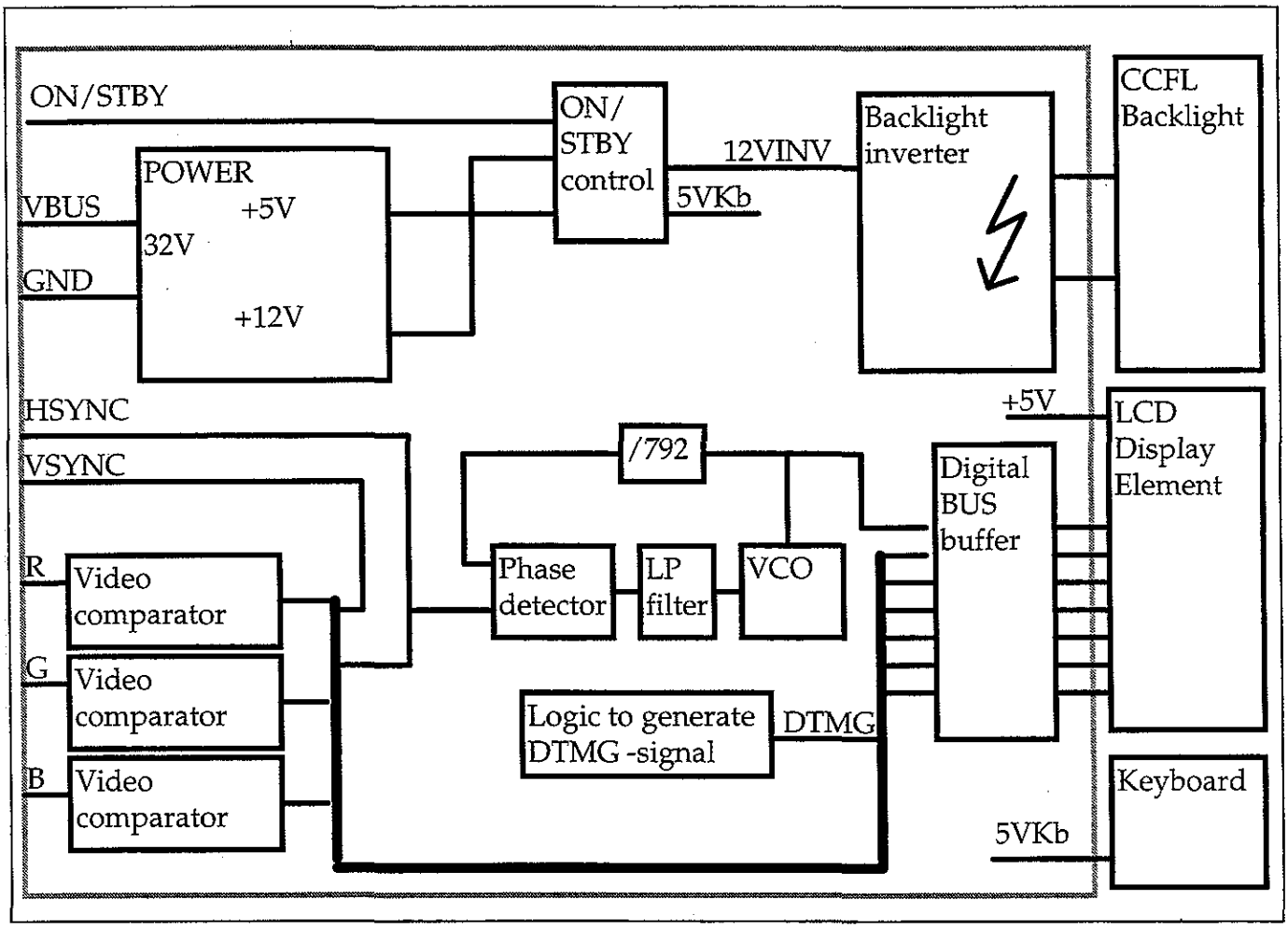


Figure 2 LCD Interface Board Block Diagram

2.1.3 External Connector Configurations

LCD Display, D-LCC10 has two external connectors. Main connector is situated at the back. It is 13 pin Coax D-connector and has pins for operating voltage (+32 Vdc), display signals, and serial communication RS232.

5-pin DIN connector (see the following page) is situated on the right side of D-LCC10.

LCD Display 13 pin Coax D-connector (main connector)

Pin No	I/O	Signal	Notes
1	I	Dirty Ground	
2	I	Intensity	
3	I	Hsync2	horiz. deflect
4	I	Vsync2	vert. deflect
5	I	Contrast	
6	I	+32 Vdd	
7	I	GND	
8	O	RXDD RS232	from keyboard
9	I	TXDD RS232	to keyboard
10	I	ON/STBY	active GND
A1	I	BLUE GND & BLUE VIDEO 2	
A2	I	GREEN GND & GREEN VIDEO2	
A3	I	RED GND & RED VIDEO2	

5-pin DIN connector (PC-connector)

Pin No	I/O	Signal	Notes
1	O	CLK	
2	I/O	DATA	
3		not connected	
4		GND	
5	O	+5 Vdc	

26-pin male D-connector at the end of Interface cable (AS/3, Display controller board side)

Pin No	I/O	Signal	Notes
1	O	RED VIDEO2	
2	O	GREEN VIDEO2	
3	O	BLUE VIDEO2	
4		BLANK	not used
5			
6	O	GND	chassis
7			
8	O	Hsync2	horiz. deflect
9	O	Vsync2	vert. deflect
10	O	RED GND	
11	O	GREEN GND	
12	O	BLUE GND	
13	O	GND	chassis
14	O	DCLK GND	
15		not connected	
16		ON/STBY	active GND
17	O	Dirty GND	
18	O	Dirty GND	
19	I	RXDD RS232	from keyboard
20	O	TXDD RS232	to keyboard
21		not connected	
22		not connected	
23		not connected	
24		not connected	
25	O	+32 Vdd	
26	O	+32 Vdd	

2.2 Display Controller Board: High Resolution Display, B-DISP

2.2.1 Functional Description

B-DISP board is connected to the CPU Mother board. The processor on the CPU board transmits program through the AS/3 bus to B-DISP board.

B-DISP board includes the functions of both B-DHIGH and B-DVGA boards. Thus, B-DISP board supports both high resolution and VGA resolution. The resolution is automatically selected based on monitor ID codes. The resolution is set to 640x480 if a VGA resolution display is used, otherwise the resolution is set to 1984x512.

NOTE: S-STD96 and S-ARK96 softwares support B-DISP, B-DHIGH and B-DVGA boards. If, however, B-DISP board is used to drive D-VHC14 display, a small part of the resulting picture will be clipped.

System Memory

The system memory contains the GSP software code. The memory consists of two 256kx16 memory banks.

Frame Memory

The frame memory contains digital display data. The size of the memory is 1 Mbyte making 1984x512 display resolution with 256 colours possible. The memory consists of four 256kx8 VRAM memory circuits.

Video Interface Palette

The video interface palette reads the digital display data from the frame memory and converts the data into analog RGB-signals. The synchronization signals for the conversion are generated by the GSP.

The video interface palette is clocked by two pixel clocks. A 25 MHz clock is selected for VGA resolution and a 40 MHz clock is

selected for high resolution. The 40 MHz clock is internally converted into a 80 MHz clock.

Graphics System Processor (GSP)

There are four 16-bit registers in the GSP, from which the host-processor reads and to which it writes data.

Display Controller Resolution

The resolution of the display controller depends on initialization of the GSP's registers and frequency of the video oscillator.

Reset Signal

Reset signal comes from the Power supply unit through the AS/3 bus.

Monitor ID Register

The monitor ID register contains a three bit (numeric values 0-7) monitor ID code. The register is connected to channels 11-13 of the X3 D-connector. If no display is connected to B-DISP board or if the monitor ID code fails, 111 code is generated by pull-up resistors. If the ID code is 011 or 101, VGA resolution is selected, otherwise high resolution is selected.

2.2.2 Block Diagram

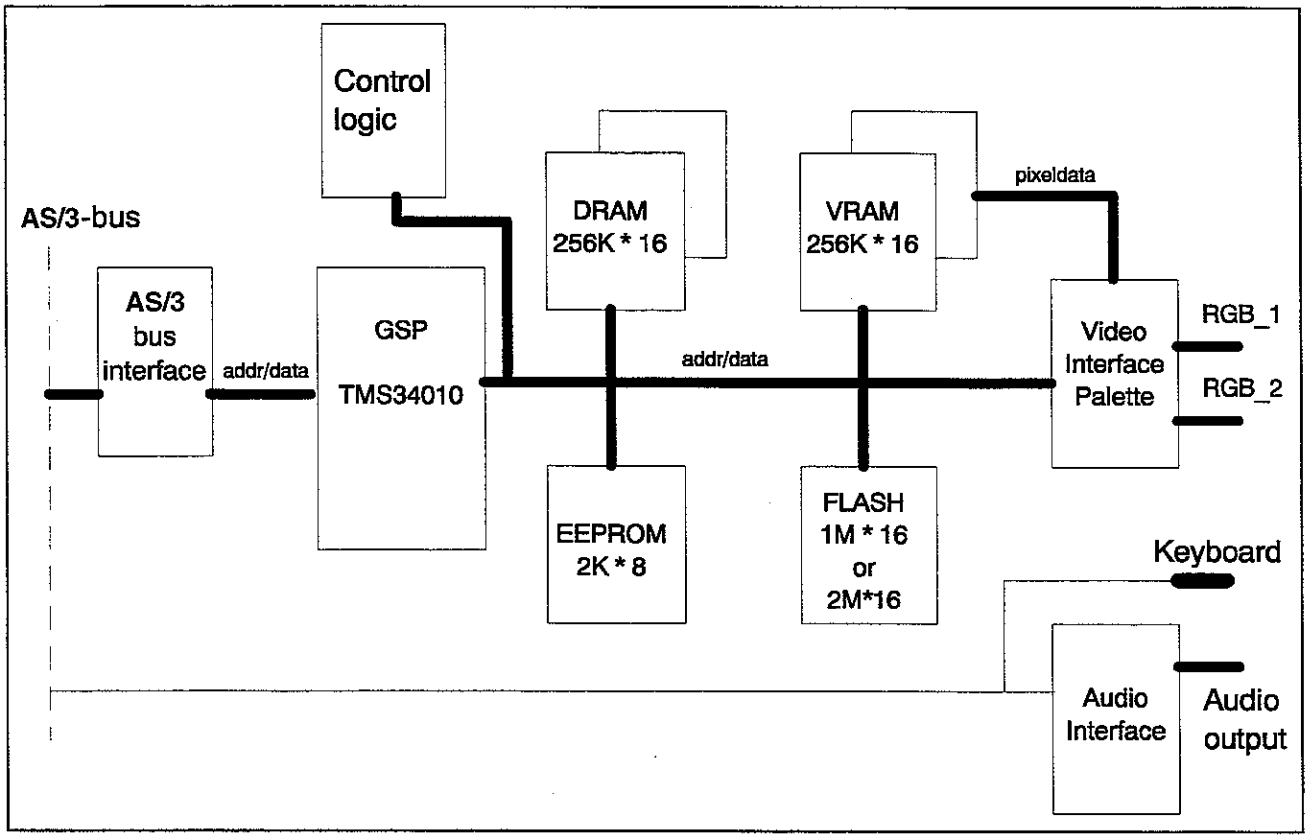


Figure 3 Display Controller Block Diagrams

2.2.3 Jumper Locations

The B-DISP board can be configured as either primary or secondary by shifting the location of J1 jumper (interrupt signal) as shown in figure 4.

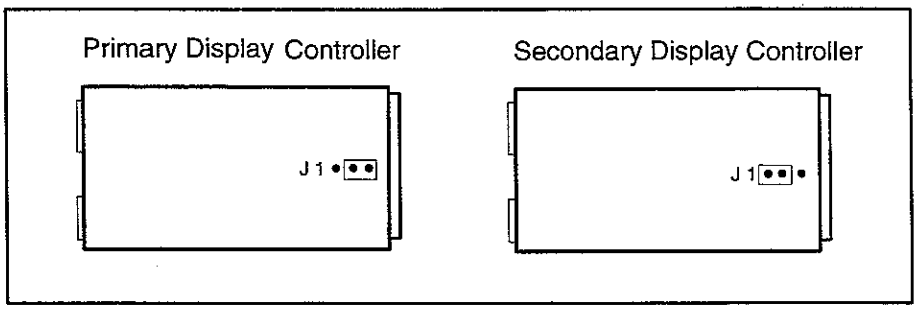


Figure 4 Jumper Locations, B-DISP Board

2.2.4 Connectors and Signals

15-pin D-connector X2 on B-DISP Display controller boards

Pin No	I/O	Signal	Notes
1	O	RED VIDEO 1	analog
2	O	GREEN VIDEO 1	analog
3	O	BLUE VIDEO 1	analog
4		MON1ID2	monitor identification
5	O	GND	
6	O	RED GND	
7	O	GREEN GND	
8	O	BLUE GND	
9		N/C	
10	O	SYNC GND	
11		MON1ID0	monitor identification
12		MON1ID1	monitor identification
13	O	HSYNC 1	TTL, CMOS
14	O	VSYNC 1	TTL, CMOS
15		N/C	

26-pin D-connector on B-DISP Display Controller Boards

Pin No	I/O	Signal
1	O	Red video (analog)
2	O	Green video (analog)
3	O	Blue video (analog)
4	I	MON2ID2
5	I	MON2ID1
6	O	Ground
7	I	MON2ID0
8	O	Horizontal sync
9	O	Vertical sync
10	O	Red ground
11	O	Green ground
12	O	Blue ground
13	O	Ground
14	O	Ground/Sync ground
15	O	+5 V
16	I	ON/STBY
17	O	Ground
18	O	Ground
19	I	RxD RS232
20	O	TxD RS232
21	O	Brightness
22	O	Contrast
23	O	Audbufout
24		Not connected
25	O	+32 Vd
26	O	+32 Vd

2.3 Display Controller Board: VGA Display, B-DVGA (B-DHIGH);

2.3.1 Functional Description

The Display controller board is connected to CPU Mother board. The CPU board's processor transmits program through the AS/3 bus to the Display controller board.

Graphics System Processor (GSP)

There are four 16-bit registers in the GSP, from which the host-processor reads and to which it writes data.

Display Memory

Four memory circuits (256k x 4 bit) are used.

Program Memory

Four memory circuits (256k x 4 bit) are used.

Video Signal

Serial outputs of the frame buffer memory are transferred to two Latch circuits so that two consecutive pixels (8 bits) are fed to one, and the next two consecutive pixels (8 bits) are fed to the other. Those four pixels (16 bits) are multiplexed into two consecutive pixel data bytes of 8 bits each. The data is then fed into the video palette circuit. The RGB signal is sent to the video buffer. The signal can be used with a CRT display.

Display Controller Resolution

The resolution of the display controller depends on initialization of the GSP's registers and frequency of video oscillator. The B-DHIGH board uses a 64 MHz oscillator and the B-DVGA board a 25 MHz oscillator.

Reset Signal

Reset signal comes from the Power supply unit through the AS/3 bus.

2.3.2 Block Diagram

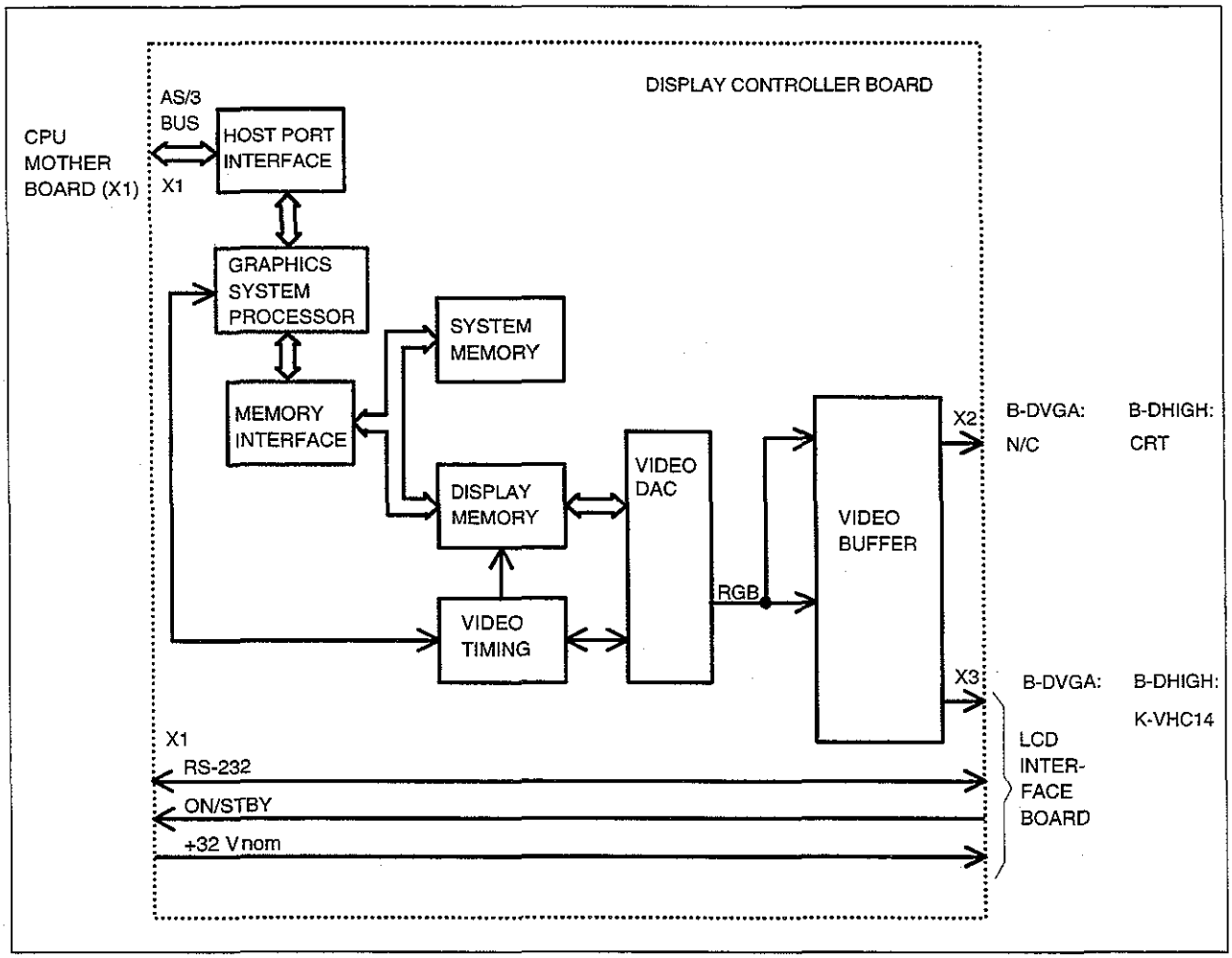


Figure 5 Display Controller Block Diagrams

2.3.3 Jumper Locations

The B-DVGA and B-DHIGH boards can be configured as either primary or secondary by shifting the location of J5 and J2 jumpers (board address and interrupt signal) as shown in figures 6 and 7.

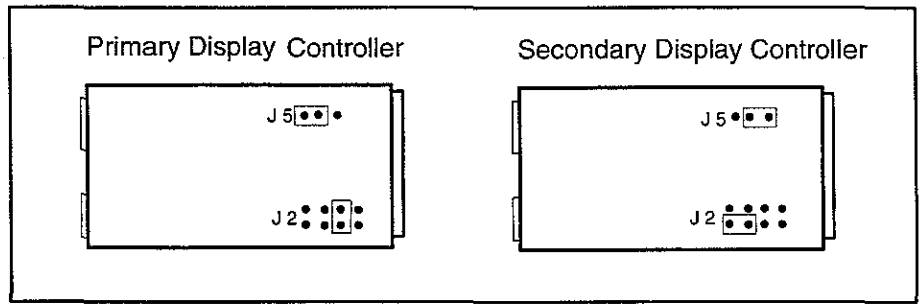


Figure 6 **Jumper Locations, B-DVGA board, revision 01, and B-DHIGH board, revision 01 (s/n < 174671)**

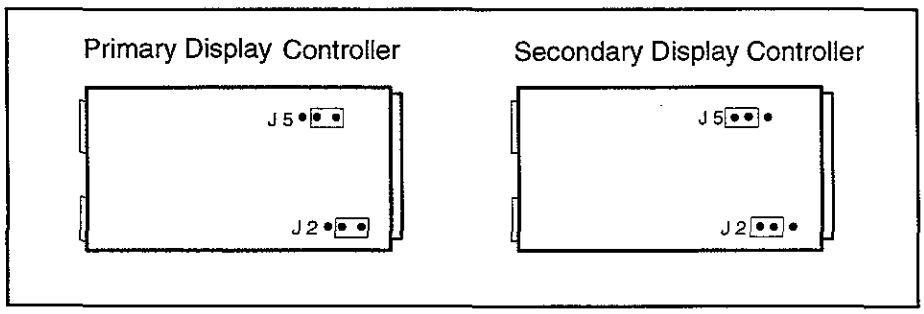


Figure 7 **Jumper Locations, B-DVGA board, revision 01-02, and B-DHIGH board, revision 01-02 (s/n > 174670)**

2.3.3 Connectors and Signals

15-pin D-connector X2 on Display controller boards

Pin No	I/O	Signal	Notes
1	O	RED VIDEO 1	analog
2	O	GREEN VIDEO 1	analog
3	O	BLUE VIDEO 1	analog
4		N/C	
5	O	GND	
6	O	RED GND	
7	O	GREEN GND	
8	O	BLUE GND	
9		N/C	
10	O	SYNC GND	
11		N/C	
12		N/C	
13	O	HSYNC 1	
14	O	VSYNC 1	
15		N/C	

26-pin D-connector on Display controller boards

Pin No	I/O	Signal
1	O	Red video (analog)
2	O	Green video (analog)
3	O	Blue video (analog)
4	O	Not connected/Blank
5		Not connected
6	O	Ground
7		Not conected
8	O	Horizontal sync
9	O	Vertical sync
10	O	Red ground
11	O	Green ground
12	O	Blue ground
13	O	Ground
14	O	Ground
15	O	+5 V
16		ON/STBY
17	O	Dirty ground
18	O	Dirty ground
19		RxD RS232
20	O	TxD RS232
21		Not connected
22		Not connected
23		Not connected
24		Not connected
25		Not connected
26		Not connected

2.4 Command Boards, K-VNC15 (K-VHC14)

The Command board consists of 17 direct function keys, ComWheel, and ON/STBY switch.

2.4.1 Functional Description

Command Board PCB

The Command board PCB is located inside the Command Board. The board reads the status of the front panel keys and the ComWheel and forwards the information to the CPU board.

External communication

Communication with the host processor takes place in RS232 serial communication channels which are available in both the AS/3 bus and module bus. Two signals, TXD and RXD, are in use. No handshaking is used.

The 26-pin subminiature D-connector of the Command Board is connected to a Display controller board.

Serial communication speed is 19.2 KBaud.

ComWheel

The ComWheel on the front panel is used for menu selection.

LEDs

The alarm LEDs are activated by the Command Board PCB under the commands received via serial communication from the CPU board. The red or yellow alarm LED is lit when red or yellow alarm is activated. "STBY" -led is lit when the device is switched to stand-by and connected to mains.

NOTE: If there are two Command Boards connected to the system, the system is ON (STBY LED not lit), when at least one of the switches is positioned ON.

2.4.2 Block Diagram

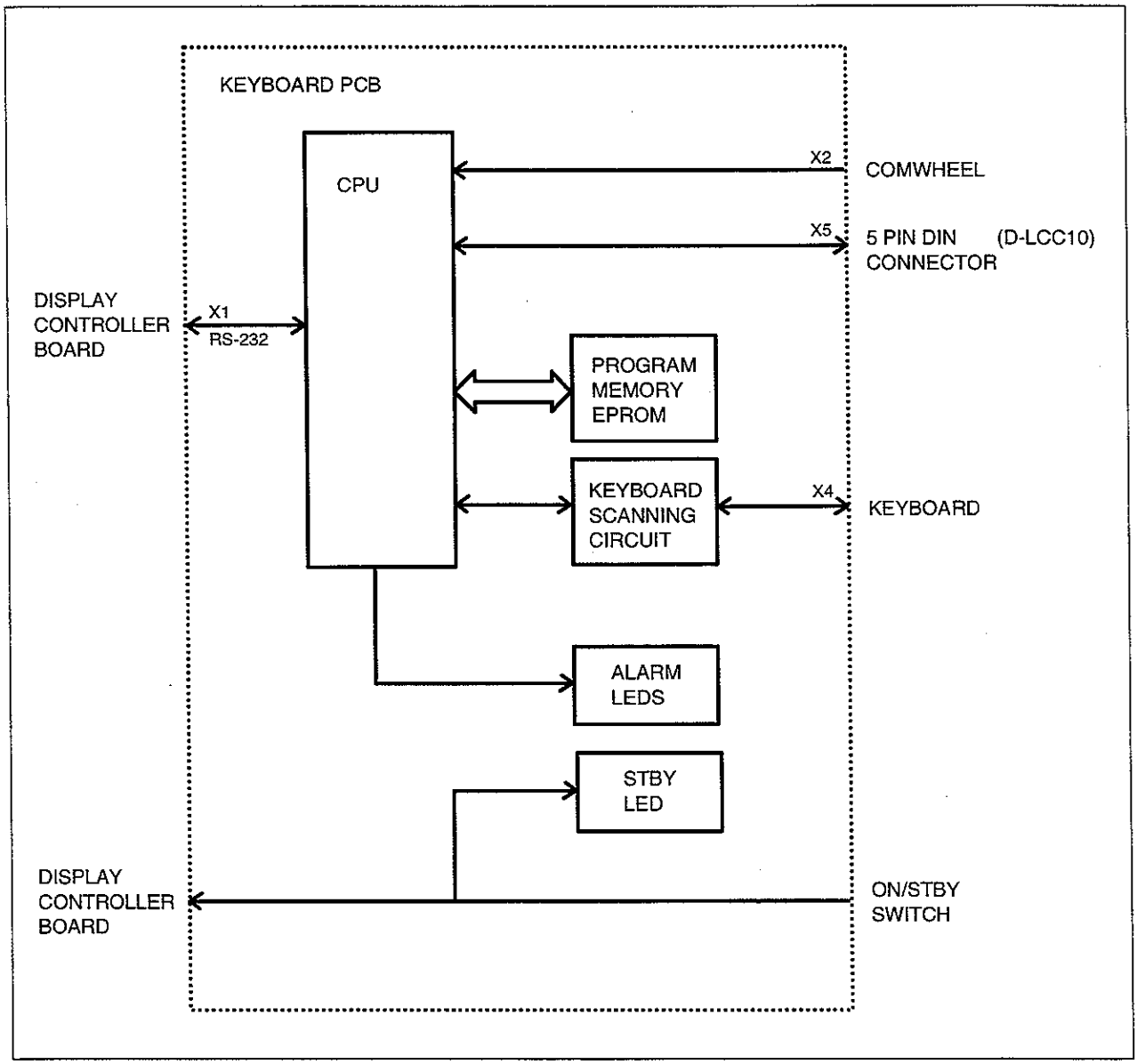


Figure 8 K-VNC15 (K-VHC14) Block Diagram

2.4.3 Connectors and Signals

Command Board 26-pin male D-connector

Pin No	I/O	Signal	Notes
1		Not connected	
2		Not connected	
3		Not connected	
4		Not connected	
5		Not connected	
6	I	GND	
7		Not connected	
8		Not connected	
9		Not connected	
10		Not connected	
11		Not connected	
12		Not connected	
13		Not connected	
14		N ot connected	
15	I	+5 V	
16	O	ON/STBY	
17		Not connected	
18		Not connected	
19	O	TXDD RS232	
20	I	RXDD RS232	
21		Not connected	
22		Not connected	
23		Not connected	
24		Not connected	
25		Not connected	
26		Not connected	

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex Technical Services is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

CAUTION: The tests and repairs outlined in this section should only be attempted by trained personnel with the appropriate equipment. Unauthorized service may void warranty of the unit.

3.2 LCD Display

NOTE: The LCD Display component and the backlight lamp are irreparable parts and they should be replaced as a whole unit whenever necessary.

3.2.3 Disassembly and Reassembly

Disassemble the LCD display according to the following procedure. Please refer to the exploded view of the LCD display (chapter 6, spare parts).

NOTE: Wear a static control wrist strap and soft cotton gloves (dust free) when handling the LCD Display parts. Do not touch connector pins.

1. Place the LCD Display on a flat surface the front side downwards.

2. Remove the screws (4) that are located at the corners of the rear panel.

3. Lift the rear panel gently, disconnect the cable(s) and set the rear panel aside.

In normal circumstances it is very difficult to keep the LCD Display component and the LCD Display shield free of dust when those are detached from the LCD Display frame. If dust particles remain on the LCD Display component and LCD Display shield surfaces, those may impair the quality of picture on the screen.

In case you need to detach the LCD Display component for repair, if you can provide a dust free environment, follow the instructions below. Otherwise, you may return the whole LCD Display to be repaired at Datex.

NOTE: If the LCD Display unit is broken, handle it carefully to avoid injury (the LCD Display component and the backlight lamp are made of glass). Wash your hands if you touched liquid crystal which may flow out from a broken LCD Display component.

NOTE: Do not touch , push or rub the exposed soft polarizer. Keep the polarizer clean. In case of accidental mishandling see the instructions following this chapter.

1. The Adapter board and its insulation plate can be detached by disconnecting the cable connectors and removing the screws (4).

2. Remove the screws (8) that are located at the back of the LCD Display unit.

3. The following parts can now be lifted off one by one:

- the Adapter unit
- the LCD Display component with the backlight
- the LCD Display shield
- the EMC cover with the LCD Display gasket

4. The Command board PCB can be detached by disconnecting the cable connectors and removing the screws (3).

(D-LCC10 Rev. 00-02)

1. The backlight unit as well as the LCD Display component can be detached by removing the screws (4) at their corners.

2. The Command board PCB can be detached by disconnecting the cable connectors and removing the screws (2).

3. The Power supply board is attached to the rear panel by four (4) screws.

Reassembly of the LCD Display is made in reversed order. Make sure that all connectors are connected properly and cables are not pinched between covers.

NOTE: The backlight unit in D-LCC10, revision 03, cannot be changed and the whole LCD display component must be sent back to the factory for repair.

3.3 Display Controller Boards

The Display controller boards can only be replaced. Please refer to the Installation manual of your monitor for instructions how to remove and replace the boards.

3.4 Command Boards

3.4.1 Preventive Maintenance Check List

We recommend that you perform these checks after any service and at least once every six months.

1. Visual inspection

__: All connectors are properly connected.

2. Functional checks

__: Check the operations of all the keys and ComWheel.

__: Check the alarm operation by changing alarm sound volume.

__: Check alarm LEDs

3.4.2 Disassembly and Reassembly

The Command Board included in the display set is disassembled according to the following procedure. Please refer to the exploded view of the Command Board (chapter 6, spare parts).

Command Board, K-VNC15

1. Disconnect the display power cable, the display data cable and the Command Board cable from the Central Unit.

2. Pull out the display power cable and the display data cable through the hole in the rear panel of the display screen tray. Leave the Command Board cable inside the tray.

3. Turn the display set upside down and unscrew the cross head screw holding the display screen tray to the display. Lift off the tray.

4. Turn the display screen tray upside down and unscrew the two screws holding the Command Board to the tray.

5. Turn the display screen tray right side up and pull off the Command Board.

6. Disconnect the Command Board cable, the wire set from the ON/STBY switch, the wire set from the ComWheel and the flat cable from the membrane keyboard.

7. Detach the Command Board PCB by pressing the two plastic fasteners holding the PCB in place and simultaneously lifting off the PCB.

The Command Board is reassembled by reversing the disassembly procedure.

Command Board, K-VHC14

1. Disconnect the display power cable, the display data cable and the Command Board cable from the Central Unit.

2. Turn the display set upside down and unscrew the cross head screw holding the display screen tray to the display. Lift off the tray.

3. Pull out the display power cable and the display data cable through the slot in the rear panel of the display screen tray.

4. Unscrew the two screws holding the Command Board to the display screen tray. Remove the tray.

5. Unscrew the two screws holding the front cover of the Command Board to the rear cover. Carefully remove the rear cover.

6. Disconnect the Command Board cable, the wire set from the ON/STBY switch, the wire set from the ComWheel and the flat cable from the membrane keyboard.

7. Detach the Command Board PCB by pressing the two plastic fasteners holding the PCB in place and simultaneously lifting off the PCB.

The Command Board is reassembled by reversing the disassembly procedure.

4 TROUBLESHOOTING

4.1 LCD Display

PROBLEM	CAUSE	TREATMENT
No image on screen and no backlight	No power or loose interface cable.	Check LCD - ON/STBY switch position and interface cable
No image on screen, backlight on	Cables may be loose. Display controller board or LCD Interface board failure	Check the items. Replace the board(s) if necessary
Vertical stripes on right side of screen continuously	Jumpers in Display controller board not positioned correctly	Check the jumpers. See Installation Manual for reference.
Only small portion of CRT screen is displayed on LCD display in zoomed-up form	LCD Display defined as High Resolution Display with the B-DVGA.	Use menu (Monitor setup-Install/Service-Screen 2 setup) to change into VGA. In S-STD95/S-ARK95 and S-STD96/S-ARK96 automatic resolution selection.
Unstable image	+5 V unstable. Loose cable. Jumpers in Display controller board not positioned correctly or board failure. LCD Interface board failure	Check cable connections. Check the jumpers. Check the board(s) and replace if necessary
Backlight flickering or dim	Backlight connector failure or lamp/LCD Interface board failure	Check the connector. Check the lamp/ LCD Interface board failure. If faulty lamp, replace the whole LCD unit. See chapter 3.1.

4.2 Display Controller Boards

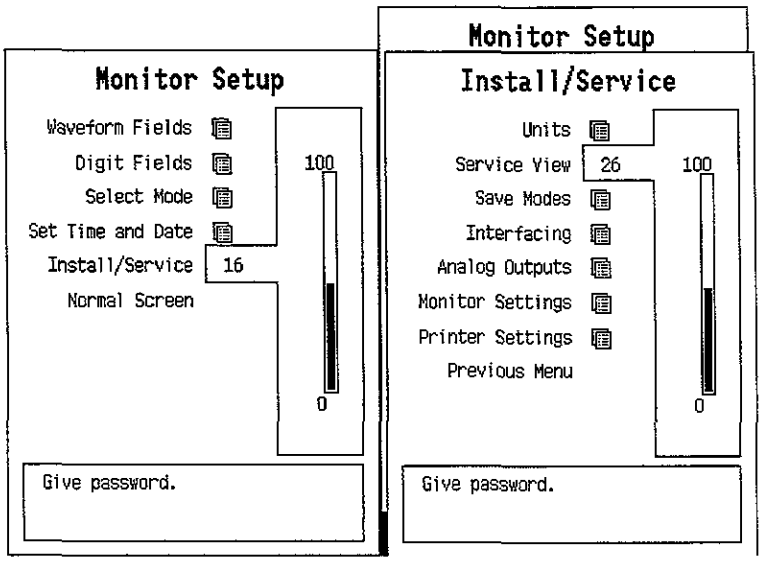
PROBLEM	CAUSE	TREATMENT
No image on the screen	No power Cable or display board loose Board or display faulty	Check power on Check cable and board connections Try with another board and/or display
Regular stripes on the picture	Faulty Display controller board	Replace the board.
B-DHIGH and B-DISP with D-VNC15 only:		
Part of the screen has wrong colours	Triac board failure	Replace triac board, see part II Central Unit, power supply.
Picture disfigured.	Outer magnetic field	Turn the monitor off, wait 10 minutes and turn the monitor on again in order to demagnetize the screen.

4.3 Command Boards

See Keyboard Service Menu in chapter 5, and perform tests available. If any of the tests fail, see explanation below.

PROBLEM	CAUSE	TREATMENT
ON/STBY switch not working	Keyboard cable loose or broken. D-26 connector pin failure. Switch leads broken. Switch connector loose. Switch faulty	Check the items. Replace them if necessary
ComWheel not working	ComWheel leads broken or connector loose. ComWheel faulty.	Check the items. Replace the ComWheel if necessary
Membrane key not working	Switch cable loose or broken. Keyboard cable loose or broken. D-26 connector pin failure. RS232 communication failure on CPU board	Check the items. Replace them if necessary.

5 SERVICE VIEW



To enter Service Menu:

1. Press the MONITOR SETUP key. The Setup menu appears.
2. Turn ComWheel to highlight Install/Service and push.
3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.
4. Turn the ComWheel to highlight Service View and push.
5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.
6. Turn the ComWheel to highlight Modules and push.
7. Turn the ComWheel to highlight the right module and push.

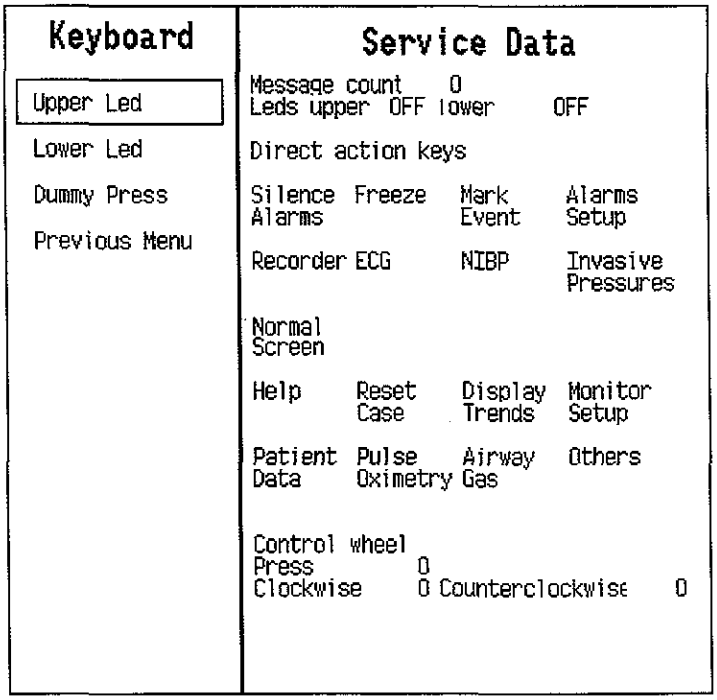
5.1 LCD Display

There is no separate service menu for the LCD Display.

5.2 Display Controller Boards

There is no separate service menu for Display controller boards.

5.3 Command Boards



Menu items:

1. Silence Alarm upper LED (red) check
2. Silence Alarm lower LED (yellow) check
3. ComWheel pressing check
4. Return to previous menu

Service Data

Message count counts whenever a function is selected.

Leds upper and **Leds lower** indicate Silence Alarms leds' state.

Direct action keys: the key item changes its colour when the key is pressed. If not the key may be damaged.

Control wheel: Pressing and turning the ComWheel **Clockwise** and **Counterclockwise** are counted.

All counters are zeroed when the menu is closed.

6 SPARE PARTS

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

* = the part is recommended for stock

Item numbers refer to the exploded view.

6.1 Spare Parts Lists

14" Color Display, D-VHC14

Item description	Order No.
Display cover, D-VHC14 (w/o stickers)	902661
Monitor cable, D-VHC14	*902660
Display power cord, D-VHC14 (EUR/USA)	545581
Service Manual for D-VHC14 (Hitachi)	572772

* = the part is recommended for stock

15" Color Display, D-VNC15

Rev. 00 (see figure 9)

Item	Item description	Order No.
1	Locking washer, D-VNC15	889164
2	Motion limiter for 889164	889165
5	Power cord guard, D-VNC15	889704
	STBY switch cover, D-VNC15	889325
6	Cross cylinder head screw M3x8	61722
3	Cross cylinder head screw M6x16	61775

* = the part is recommended for stock

LCD Display, D-LCC10

Rev. 01 (see figure 10)

Item	Item description	Order No.
6	Power supply board, D-LCC10 (Rev. 01-02)	*881808
3	Command board PCB, D-LCC10 (Rev. 01-02)	*(883022) Use 886821 [1] 887874
2	Membrane keyboard, AS/3 AM/CM	879373
4	LCD Module, AS/3 AM/CM	572770
5	Backlight unit, AS/3 AM/CM	*883929
	Inverter for back light unit, AS/3 AM/CM	*572776
	Adapter board for back light unit, AS/3 AM/CM	883269
10	Rotary wheel	879872
9	ComWheel cover and spring	879191
7	ON/STBY switch	*879871
8	ON/STBY switch protector	881431
1	Front panel sticker, D-LCC10 (Rev. 01) (Eng)	879479
1	Front panel sticker, D-LCC10 (Rev. 01) (Ger)	880469
1	Front panel sticker, D-LCC10 (Rev. 01) (Fre)	880161
11	Internal cable (Power to Keyboard)	881807
12	Internal cable (Power to LCD)	881721
13	Internal cable (Personal Computer)	881826
	External cable 2.5 m (LCD Display to AS/3 AM)	(881966) Use 885517

Rev. 02 (see figure 10)

Item	Item description	Order No.
1	Front panel sticker, D-LCC10 (Rev. 02-03) (Eng)	885878
1	Front panel sticker, D-LCC10 (Rev. 02-03) (Ger)	885879
1	Front panel sticker, D-LCC10 (Rev. 02-03) (Fre)	885880
	External cable 2.5 m (LCD Display to AS/3 AM)	885517
	External cable 6 m (LCD Display to AS/3 AM)	884976

Rev. 03 (see figure 11)

Item	Item description	Order No.
3	Command board PCB, AS/3 AM/CM	*886821
	Command board software	*887874
16	LCD display gasket, AS/3 AM/CM	887719
17	LCD display shield, AS/3 AM/CM	572787
18	LCD display unit, complete, AS/3 AM/CM	887737
19	LCD display (contains the backlight), AS/3 AM/CM	572784
20	Adapter unit, AS/3 AM/CM	887125
21	Flat cable	71409
22	Adapter board, AS/3 AM/CM	887840
23	Insulation plate	887739
24	Connector board (LCD), AS/3 AM/CM	888220
25	Connector board (frame), D-LCC10 (Rev.03)	888222
1	Front panel sticker, D-LCC10 (Rev. 03) (Spa)	886272
1	Front panel sticker, D-LCC10 (Rev. 03) (Swe)	885946
1	Front panel sticker, D-LCC10 (Rev. 03) (Dut)	886043
1	Front panel sticker, D-LCC10 (Rev. 03) (Ita)	886751
1	Front panel sticker, D-LCC10 (Rev. 03) (Fin)	888860
26	Rear cover, D-LCC10 (Rev. 03)	889367
	External cable 2.5 m (LCD Display to AS/3 AM)	888525
	External cable 10 m (LCD Display to AS/3 AM)	888643

* = the part is recommended for stock

[1)] The Command board 886821 can be used as a replacement only with Command board software 887874.

NOTE: If you have to replace rear cover, please remove the type data sticker and send it to us. We will send you a new rear cover with reprinted sticker on it.

Display Controller Boards

Item description	Order No.
Grounding plate	885398

* = the part is recommended for stock

Command Board, K-VHC14 (see figure 12)

Rev. 01

Item	Item description	Order No.
15	Command board PC board, K-VHC14 (Rev. 01)	*(880310) Use 883228
3	ON/STBY switch	*879871
4	ON/STBY switch protector	881431
5	Rotary wheel	879872
2	ComWheel cover and spring	879191
13	Plastic front cover, K-VHC14 (Rev. 01)	879087
14	Plastic rear cover, K-VHC14 (Rev. 01)	879088
1	Front panel sticker, K-VHC14 (Rev. 01) (Eng)	879479
1	Front panel sticker, K-VHC14 (Rev. 01) (Ger)	880469
1	Front panel sticker, K-VHC14 (Rev. 01) (Fre)	880161
16	Keyboard membrane, AS/3 AM/CM	879373
6	Command board cable, K-VHC14 (Rev.01)	*(880358) Use 883229
9	Cross cylinder head screw M3x12	61736
7	Cross cylinder head screw M3x8	61722
11	Star washer M3.2	63611
8	Display screen tray	879474
10	Display rear plug cover	879475

Rev. 02 (see figure 12)

Item	Item description	Order No.
15	Command board PC board, K-VHC14 (Rev. 02)	*883228
6	Command board cable, K-VHC14 (Rev.02)	*883229
13	Plastic front cover, K-VHC14 (Rev. 02)	883178
14	Plastic rear cover, K-VHC14 (Rev. 02)	883177
1	Front panel sticker, K-VHC14 (Rev. 02) (Eng)	885878
1	Front panel sticker, K-VHC14 (Rev. 02) (Ger)	885879
1	Front panel sticker, K-VHC14 (Rev. 02) (Fre)	885880
1	Front panel sticker, K-VHC14 (Rev. 02) (Spa)	886272
1	Front panel sticker, K-VHC14 (Rev. 02) (Swe)	885946
1	Front panel sticker, K-VHC14 (Rev. 02) (Dut)	886043
1	Front panel sticker, K-VHC14 (Rev. 02) (Ita)	886751
1	Front panel sticker, K-VHC14 (Rev. 02) (Fin)	888860

* = the part is recommended for stock

NOTE: Parts listed in Rev.1 and 2 Spare parts lists are not interchangeable

Command Board, K-VNC15

Rev. 00 (see figure 13)

Item	Item description	Order No.
3	Command board PC board, K-VHC14, K-VNC15	*883228
13	ON/STBY switch	*879871
7	ON/STBY switch protector	881431
14	Rotary wheel	879872
18	ComWheel cover	879191
5	Plastic front cover, K-VHC14 (Rev. 02), K-VNC15	883178
6	Keyboard membrane, AS/3 AM/CM	879373
15	Front panel sticker, K-VNC15 (Rev. 00) (Eng)	885878
15	Front panel sticker, K-VNC15 (Rev. 00) (Ger)	885879
15	Front panel sticker, K-VNC15 (Rev. 00) (Fre)	885880
15	Front panel sticker, K-VNC15 (Rev. 00) (Spa)	886272
15	Front panel sticker, K-VNC15 (Rev. 00) (Swe)	885946
15	Front panel sticker, K-VNC15 (Rev. 00) (Dut)	886043
15	Front panel sticker, K-VNC15 (Rev. 00) (Ita)	886751
15	Front panel sticker, K-VNC15 (Rev. 00) (Fin)	888860
2	Command board cable, K-VNC15	*889206
1	Display screen tray, K-VNC15	889162
	Pad	65142
10	Cable clamp	64076
11	Cross cylinder head screw M3x8	61722
4	Bushing	640444

* = the part is recommended for stock

6.2 Exploded Views

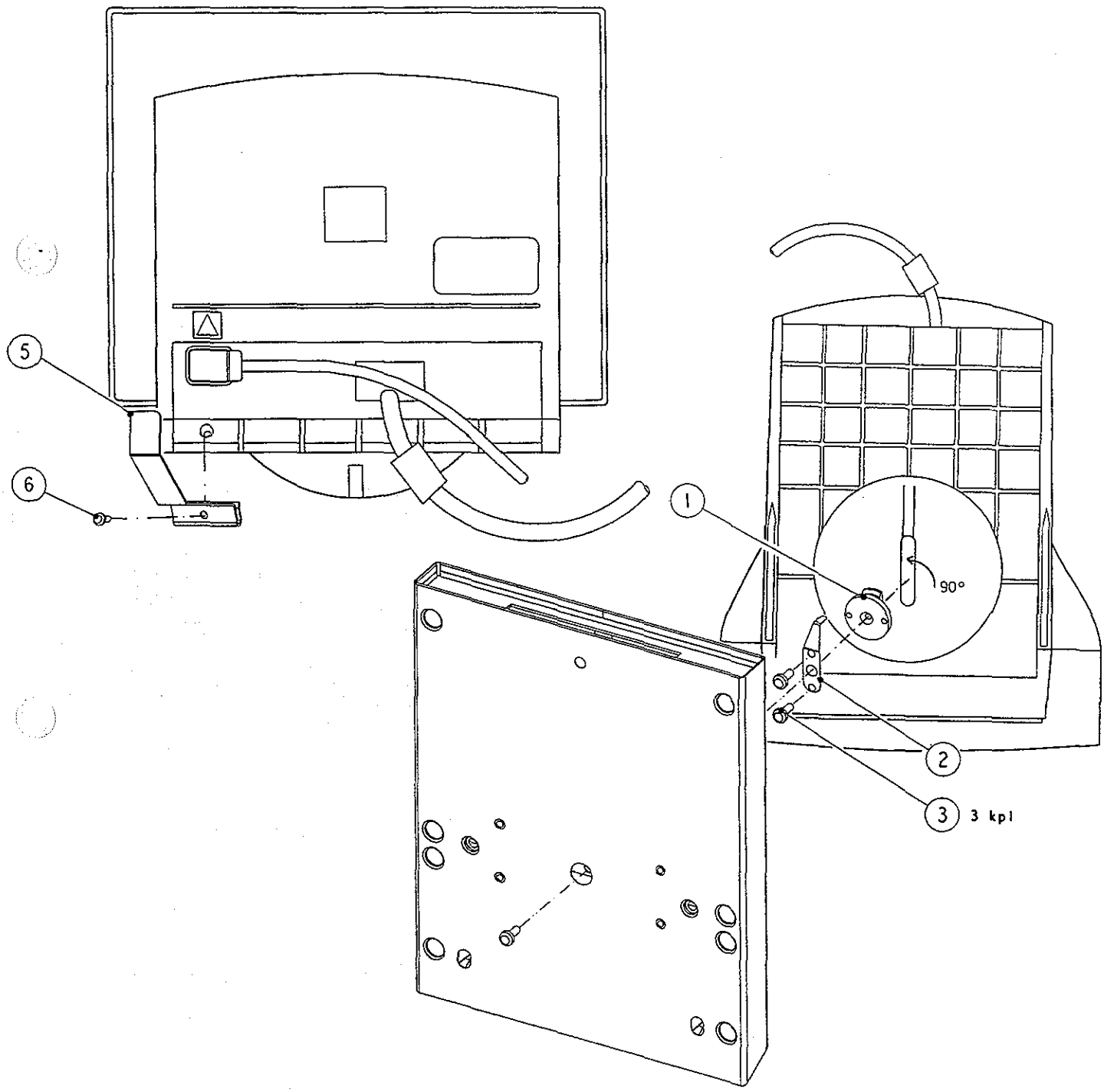


Figure 9 **Exploded View of Video Display, D-VNC15**

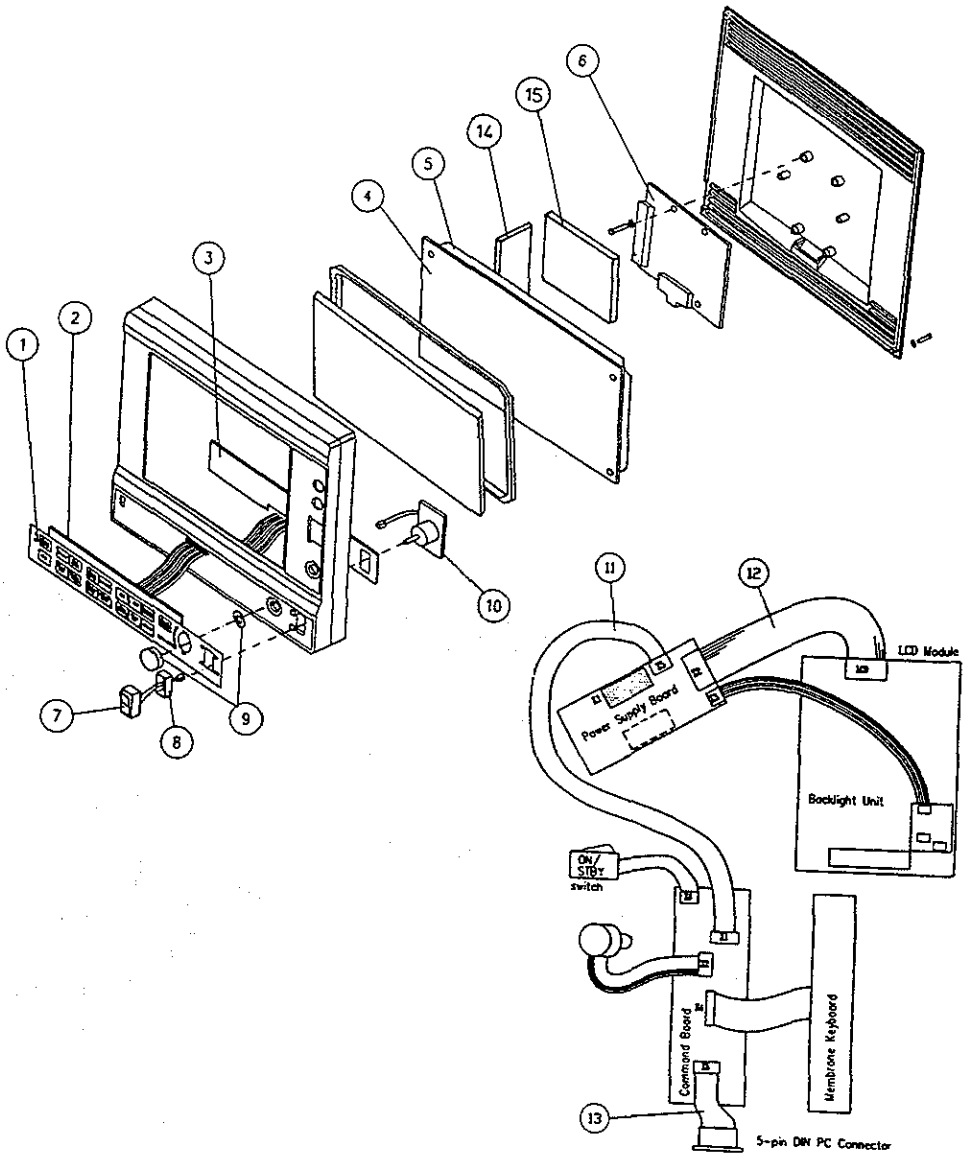


Figure 10 Exploded View of LCD Display (Revisions 01 and 02)

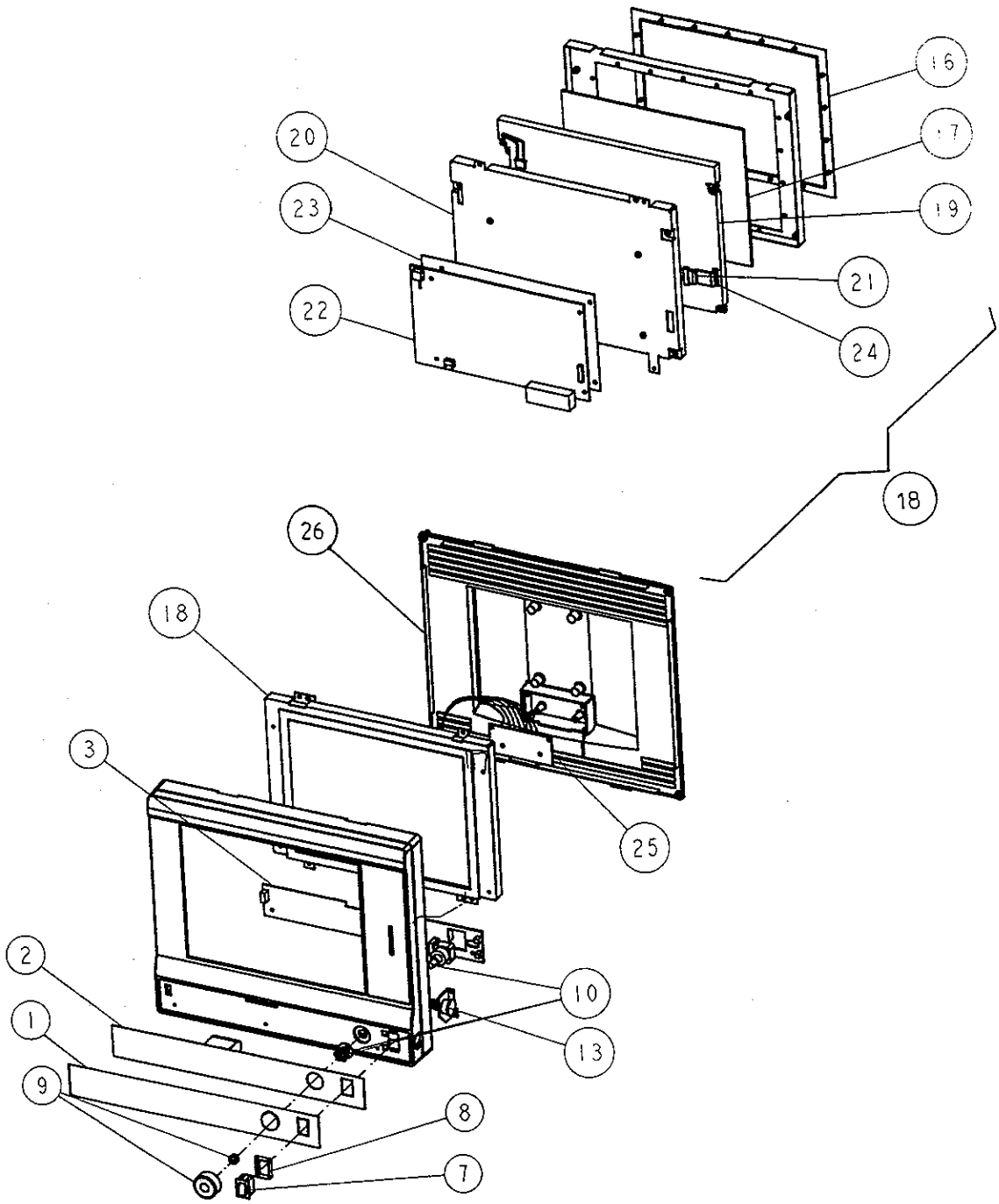


Figure 11 Exploded View of LCD Display (Revision 03)

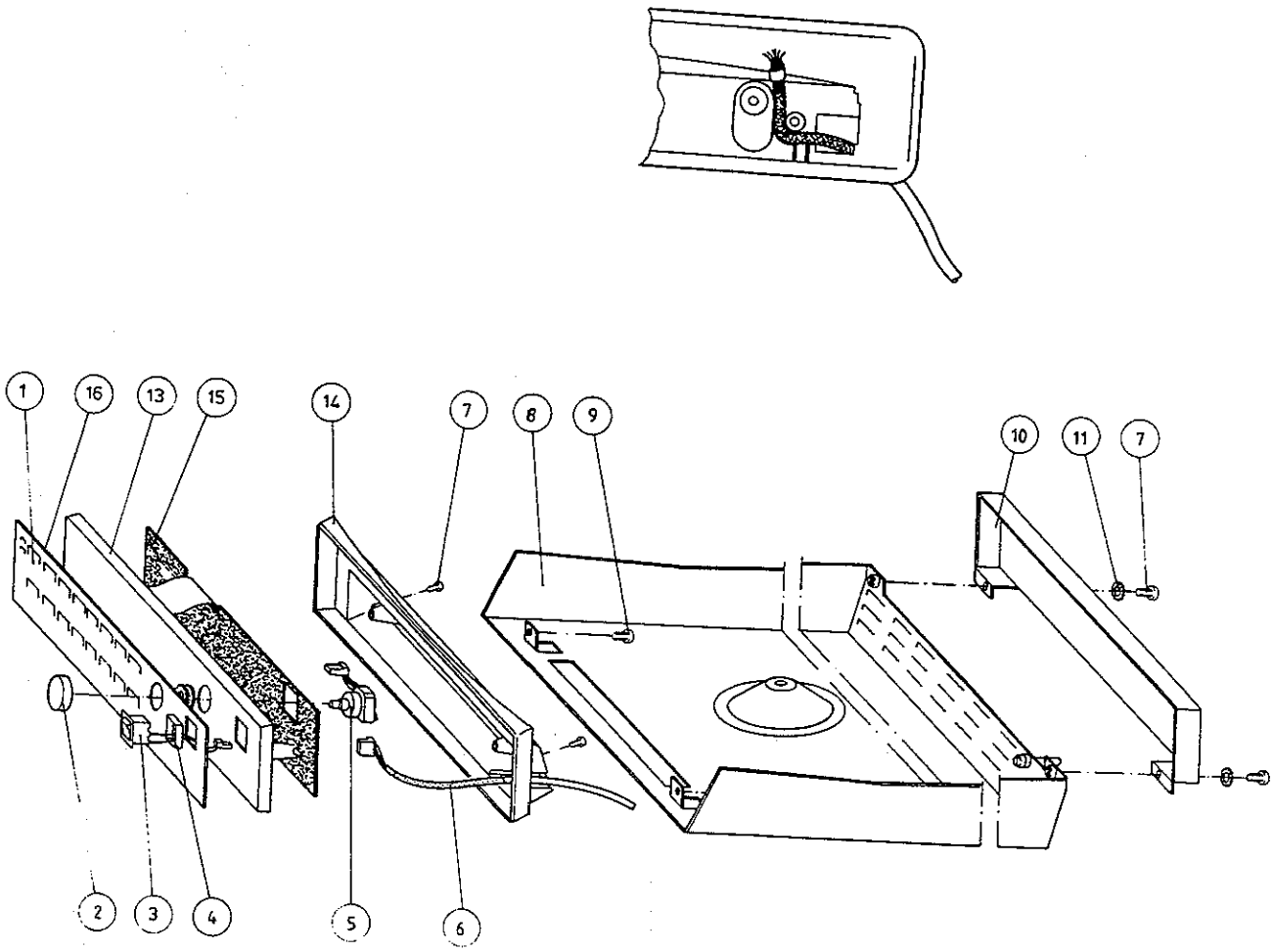


Figure 12 Exploded View of Command Board, K-VHC14

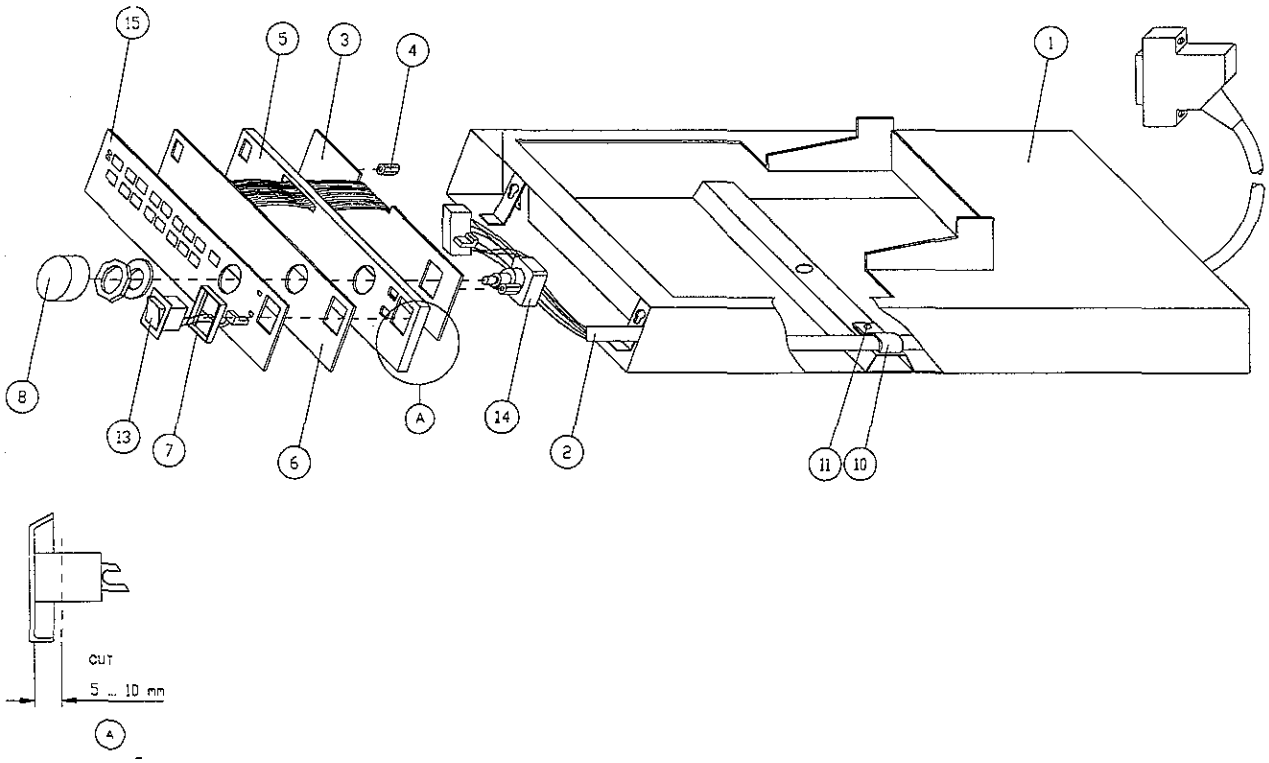


Figure 13 Exploded View of Command Board, K-VNC15

7 EARLIER REVISIONS

For more service information on the earlier revisions, please refer to:

Command Board revision 01	Service Manual p/n 880850
Command Board revision 02	Service Manual p/n 885930
LCD-Display revision 01	Service Manual p/n 882580
LCD-Display revision 02	Service Manual p/n 885930

This manual supports all later revisions.

ESTPR Module, M-ESTPR (Rev. 01)

ETPR Module, M-ETPR (Rev. 01)

ESTR Module, M-ESTR (Rev. 01)

All specifications subject to change without notice

Document No. 885933-4

March, 1996

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Table of Contents

INTRODUCTION **1**

1 SPECIFICATIONS **2**

1.1 General Specifications 2
1.2 Typical Performance 2
1.3 Technical Specifications 5

2 FUNCTIONAL DESCRIPTION **7**

2.1 Measurement Principle 7
2.2 Main Components 12
2.2.1 STP Board 13
2.2.2 ECG Board 21
2.2.3 Module Bus Connector Configuration 25
2.2.4 Front Panel Connectors 26

3 SERVICE PROCEDURES **27**

3.1 General Service Information 27
3.2 Preventive Maintenance 27
3.3 Disassembly and Reassembly 31
3.4 Adjustments and Calibrations 32

4 TROUBLESHOOTING **34**

4.1 Troubleshooting Charts 34

5 SERVICE MENU **41**

5.1 ECG Service Menu 42
5.2 STP Service Menu 44
5.2.1 Calibration Menu 47

6 SPARE PARTS **48**

6.1 Spare Parts List 48
6.2 Exploded View 52

7 EARLIER REVISIONS **54**

INTRODUCTION

Datex AS/3 Modules M-ESTPR, M-ESTR, and M-ETPR are double width modules that provide general haemodynamic parameters followingly:

M-ESTPR:
ECG with ST-segment analysis, pulse oximetry, two temperatures, two invasive blood pressures and respiration measurement.

M-ESTR:
ECG with ST-segment analysis, pulse oximetry, two temperatures and respiration measurement.

M-ETPR:
ECG with ST-segment analysis, two temperatures, two invasive blood pressure measurements and respiration measurement.

Use this manual with the module revisions M-ESTPR 01, M-ETPR 01, and M-ESTR 01. Information on revisions M-ESTP 04 and 03, M-ETP 03 and 02, and M-EST 03 and 02 is also available, but for older module revisions see other manuals indicated in chapter 7.

1 SPECIFICATIONS

1.1 General Specifications

Module size: W x D x H	75 x 180 x 112 mm 3.0 x 7.1 x 4.4 in
Module weight:	0.6 kg / 1.3 lbs
Power consumption:	6 W
Operation temperature	10..40 °C / 50..104 F °

1.2 Typical Performance

ECG

Lead selection	I, II, III, aVR, aVL, aVF, V
Sweep speeds	12.5, 25, 50 mm/sec
DISPLAY FILTER	
Monitoring	0.5 to 30 Hz (-3 dB, with 50 Hz reject filter) 0.5 to 40 Hz (-3 dB, with 60 Hz reject filter)
Diagnostic	0.05 to 100 Hz
ST filter	0.05 to 30 Hz (with 50 Hz reject filter) 0.05 to 40 Hz (with 60 Hz reject filter)
HEART RATE	
Range	30 to 250 /min
Accuracy	±5 bpm or ±5 %; whichever is greater
Resolution	1 bpm
Update interval	5 s
Averaging time	10 s
ST LEVELS (in main software)	
ST level range	-6 to +6 mm (-0.6 to +0.6 mV)
Resolution	0.1 mm (0.01 mV)
Averaging	calculated from 16 QRS

In learning mode:	
- update interval	beat to beat
- no averaging	

SYNCHRONIZATION	
Direct ECG	analog output of ECG , 1 V/1 mV
Pacer	5 V pulse 1 ms < 20 ms after pacer peak
Defibrillator synchronization	5 V pulse 10 ms < 35 ms after R-point

Invasive Blood Pressure

MEASUREMENT RANGE:	-40 to 320 mmHg
Zero adjustment range	±150 mmHg
Calibration range	±20 %
Scales	Upper limit is adjustable between 10 and 300 mmHg in steps of 10. Lower limit is 10 % of selected upper limit below zero.
Sweep speed	12.5, 25, 50 mm/s

DIGITAL DISPLAY:	
Range	-40 to 320 mmHg
Resolution	±1 mmHg

WAVEFORM DISPLAY:	
Range	-30 to 300 mmHg

HEART RATE FROM ARTERIAL PRESSURE:	
Measurement range	30 to 250 bpm
Resolution	1 bpm
Accuracy	±5 bpm or ±5 % whichever is greater

Temperature

Measurement range	10 to 45 °C (50 to 113 °F)

(In rev. ESTP 03/ EST 02/ETP 02 or earlier 15 to 45 °C (59 to 113 °F))

Display resolution	0.1 °C (0.1 °F)
Temperature test	Automatic (every 10 min.)

YSI 400 probe compatible

Pulse Oximetry

SpO_2:	
Measurement range	40 to 100 %
Accuracy	100 to 80 %: ±2 digits
(%SpO_2 ±1 SD) *)	80 to 50 %: ±3 digits
	50 to 0 %: unspecified
Resolution	1 digit = 1 %
Display averaging	20, 10 sec, beat-to-beat
Pulse beep pitch	Varies with SpO_2 level

The monitor is calibrated over the measurement range against functional saturation SpO_2(func)

HEART RATE FROM PLETH:	
Measurement range	30 to 250 bpm
Accuracy	30 to 100, ±5 bpm,
	100 to 250, ±5 %
Resolution	1 bpm
Display averaging	10 s
Adjustable pulse beep volume	

PLETH WAVEFORM:	
Scales	2, 5, 10, 20, 50 mod%, Auto

Start up scale is 20 mod% if AUTO is not selected to be the default setting.

*) 1 SD (standard deviation) = 68 % of all readings in the specified range in stable conditions.

Respiration

Measurement range	4...120 bpm
Accuracy	± 5 bpm or ±5 %
Resolution	1 bpm
Aveaging time	30 s
Update interval	10 s

RESPIRATION WAVEFORM	
Sweep Speeds	6.25 mm/s and 0.625 mm/s

1.3 Technical Specifications

ECG

Defibrillation protection	5000 V, 400 J
Recovery time	2 s
Input impedance	g.t. 2.5 Mohms/10Hz
System noise	<10 uV (p-p, RTI)
Allowable offset	±300 mVDC
Gain range	0.2 to 5.0 mV/cm
Pacemaker pulse detection	2 to 500 mV, 0.5 to 2 ms pulses
Protection against electrical shock	Type CF defibrillator proof

Invasive Blood Pressure

DIGITAL DISPLAY AVERAGING
Digital displays Art and P1 are averaged over 5 seconds and updated at 5 seconds intervals. All other pressures have respiration artifact rejection.

Error	±5 % or ±2 mmHg
Transducer and input sensitivity	5 uV/V/mmHg, 5 VDC 20 mA max current
Input resistance	10^{10} ohms
Zero drift	<0.1 mmHg/°C
Nonlinearity	<1 %, 0 to 200 mmHg <2 %, -40 to 0 and 200 to 320 mmHg
Gain drift	<0.05 %f.s./°C
Filter	0 to 4 - 22 Hz adjustable
Zero set accuracy	±1 mmHg
Calibration resolution	±1 mmHg
Zero time	less than 5 sec
Protection against electrical shock	Type CF defibrillation proof

NOTE: The accuracy of the measurement may be different from the specified, depending on transducer/probe used. Please check the transducer/probe specification.

Temperature

Measurement accuracy	±0.1 °C (25.0 to 45.0 °C) ±0.2 °C (10.0 to 24.9 °C)
Amplifier accuracy	±0.1 °C (25.0 to 45.0 °C) ±0.2 °C (10.0 to 24.9 °C)
Sensor accuracy	±0.1 °C (15 to 45 °C) ±0.2 °C (10 to 15 °C)
Protection against electrical shock	Type CF

NOTE: The accuracy of the measurement may be different from the specified, depending on transducer/probe used. Please check the transducer/probe specification.

Pulse Oximetry

Protection against electrical shock	Type BF

Respiration

Excitation frequency	31kHz
Breath detection	automatic, range 0.3..6 ohm manually adjustable minimum detection: 0.2, 0.4, 0.6, 0.8, 1.0
Input dynamic range	0.2..6 Ω
Input impedance range	100..5000 Ω
Waveform frequency	0.1..2 Hz (default), adjustable according to HR
Respiration Rate	min. 4 bpm max. 120 bpm
Lead off detection	> 3 MΩ

2 FUNCTIONAL DESCRIPTION

2.1 Measurement Principle

ECG

Electrocardiography analyzes the electrical activity of the heart by measuring the electrical potential produced with electrodes placed on the surface of the body.

ECG reflects:
Electrical activity of the heart
Normal/abnormal function of the heart
Effects of anaesthesia on heart function
Effects of surgery on heart function

See the Operator's Manual for electrodes positions and other information.

SpO_2

A pulse oximeter measures the light absorption of blood at two wavelengths, one in the near infrared (about 900 nm) and the other in the red region (about 660 nm) of light spectrum. These wavelengths are emitted by LEDs in the SpO_2 probe, the light is transmitted through peripheral tissue and is finally detected by a PIN-diode opposite to LEDs in the probe. Pulse oximeter derives the oxygen saturation (SpO_2) using empirically determined relationship between the relative absorption at the two wavelengths and the arterial oxygen saturation SaO_2.

In order to measure the arterial saturation accurately, pulse oximeters use the component of light absorption giving variations synchronous with heart beat as primary information on the arterial saturation.

A general limitation of the above pulse oximetry principle is that due to only two wavelengths used only two hemoglobin species can be discriminated by the measurement.

The modern Pulse Oximeters are empirically calibrated either against fractional saturation SaO_2frac,

$SaO_2frac = HbO_2/(HbO_2+Hb+Dyshemoglobin)$,

or against functional saturation SaO_2func,

$SaO_2func = HbO_2/(HbO_2+Hb)$,

which is more insensitive to changes of carboxyhemoglobin and methemoglobin concentrations in blood.

The oxygen saturation percentage SpO_2 measured by Datex AS/3 module is calibrated against the functional saturation SaO_2func. The advantage of this method is that the accuracy of SpO_2 measurement relative to SaO_2func can be maintained even at rather high concentrations of carboxyhemoglobin in blood. Independent of the calibration method, pulse oximeter is not able to correctly measure oxygen content of the arterial blood at elevated carboxyhemoglobin or methemoglobin levels.

Plethysmographic pulse wave

The plethysmographic waveform is derived from the IR signal and reflects the blood pulsation at the measuring site. Thus the amplitude of the waveform represents the perfusion.

Pulse rate

The pulse rate calculation is done by peak detection of the plethysmographic pulse wave. The signals are filtered to reduce noise and checked to separate artifacts.

Probe

The standard probe is a finger clamp probe which contains the light source LEDs in one half and the photodiode detector in the other half. Different kinds of probes are available from Datex.

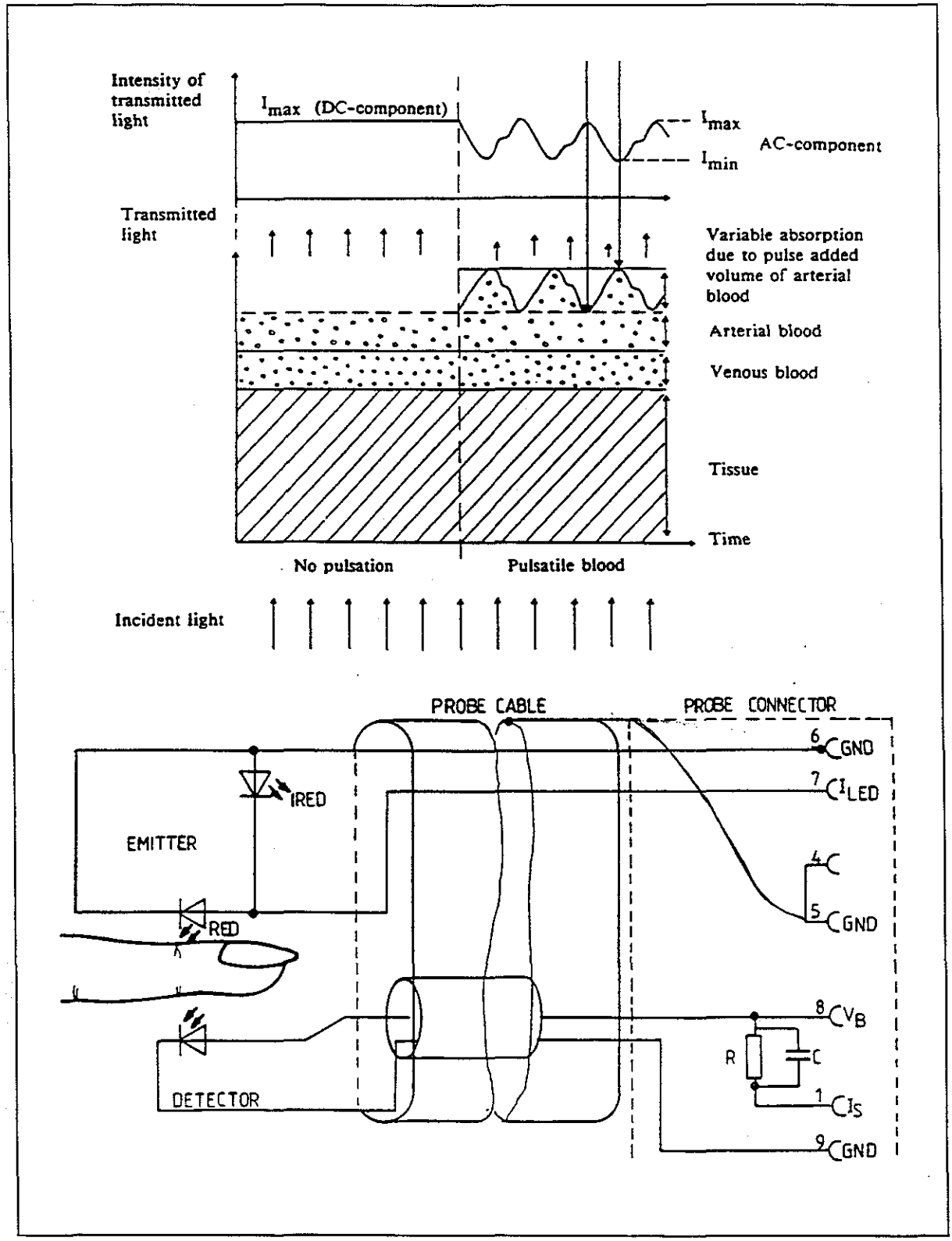


Figure 1 **Absorption of Infrared Light in the Finger and Finger Probe Parts Layout and Schematic diagram.**

Invasive Blood Pressure

To measure invasive blood pressure, a catheter is inserted into an artery or vein. The invasive pressure setup, consisting of connecting tubing, pressure transducer, an intravenous bag of normal saline all connected together by stopcocks, is attached to the catheter. The transducer is placed level with the heart, and electrically zeroed.

The transducer is a piezo-resistive device that converts the pressure signal to a voltage. The monitor interprets the voltage signal so that pressure data and pressure waveforms can be displayed.

Temperature

The temperature is measured by a probe whose resistance varies when the temperature changes, called Negative Temperature Coefficient (NTC) resistor.

The resistance can be measured by two complementary methods:

1. Applying a constant voltage across the resistor and measuring the current that flows through it.

2. Applying a constant current to flow through the resistor and measuring the voltage that is generated across it.

In AS/3 module the two methods are combined in a form of a voltage divider. The NTC-resistor is connected in series with a normal resistor and a constant voltage is applied across them. The temperature dependent voltage can be detected at the junction of the resistors, thus producing the temperature signal from the patient. The signal is amplified by analog amplifiers and further processed by digital electronics.

Respiration

Impedance respiration is measured across the thorax between three ECG electrodes. The signal of the respiration is made by supplying current between two electrodes and by measuring the differential current from the third electrode.

The input current is 200 µA (31kHz). The impedance measured is the impedance change caused by breathing. When the patient is breathing or is ventilated, the volume of the air in the lungs changes, resulting the impedance between the electrodes. From these impedance changes, respiration rate is calculated, and respiration waveform is displayed on the screen.

2.2 Main Components

The **ESTPR/ETPR/ESTR module** contains two main PC boards: the STP board and ECG board. They work independently. Both of them has their own processor and software EPROM. Some components on the boards are not used in ETPR and ESTR modules.

In **ESTPR module**, additionally, there are two small boards, the SP input and ECG input boards, attached to the front panel. The front panel has six connectors and four keys. The connectors are two for temperature measurement, two for invasive blood pressure measurement, one for ECG, and one for SpO_2 measurement. The keys are for ECG lead, Start Wedge, P1 zero, and P2 zero.

In **ETPR module**, there are two small boards: the ECG input board and 2P input board attached to the front panel. The front panel has five connectors and four keys. The connectors are two for temperature measurement, two for invasive blood pressure measurement, and one for SpO_2 measurement. The keys are for ECG lead, Start Wedge, P1 zero, and P2 zero.

In **ESTR module**, there are two small boards: the SP input board and ECG input board, attached to the front panel. The front panel has four connectors and two keys. The connectors are two for temperature measurement, one for ECG, and one for SpO_2 measurement. The keys are for ECG lead and Start Wedge.

NOTE: Revisions M-ESTP rev. 03, M-ETP rev. 02 and M-EST rev. 02 and all earlier revisions had separate T and SP input boards.

2.2.1 STP Board

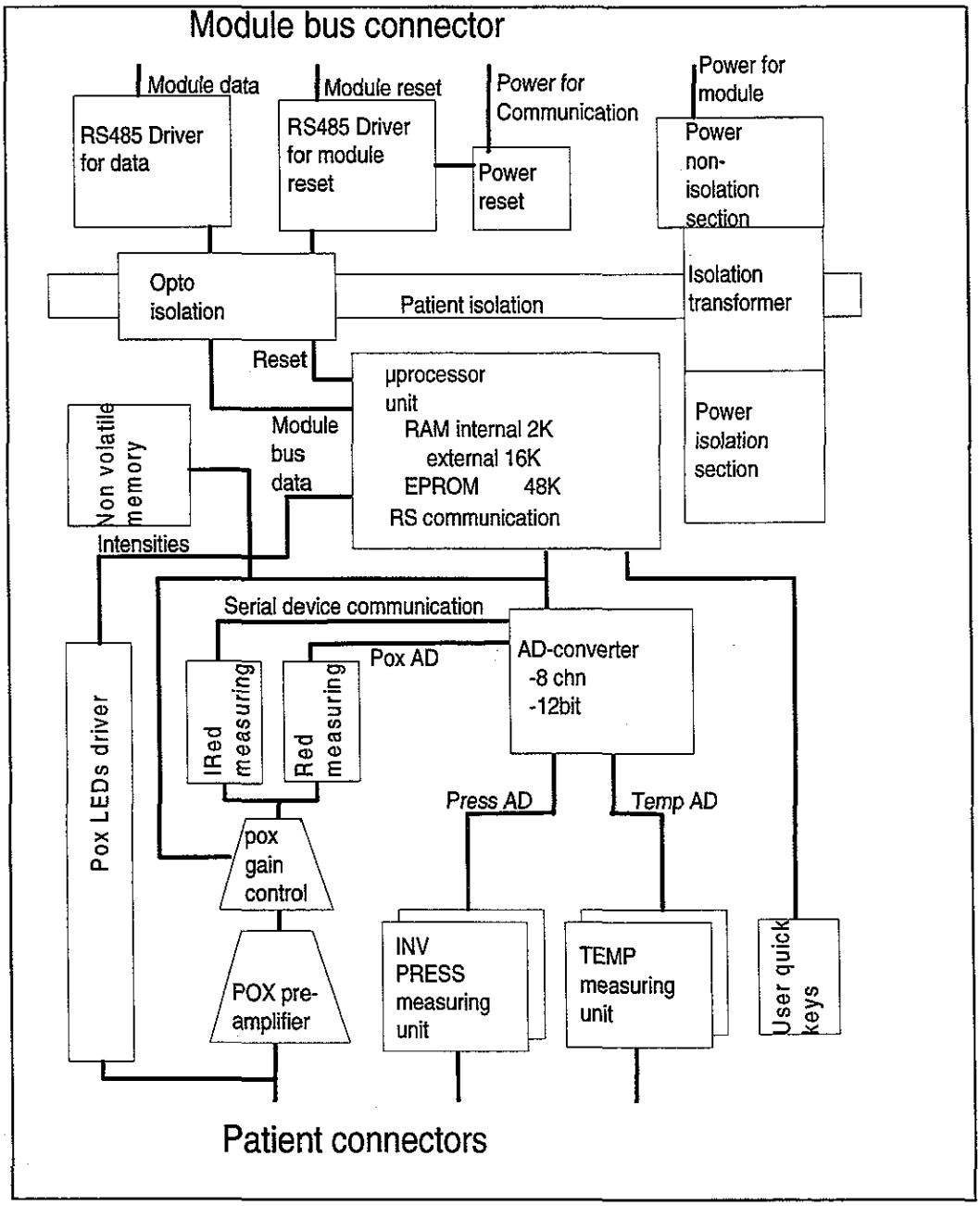


Figure 2 STP Board Block Diagram

Processor section

As processor, Intel's 80C196KC-16 is used. There are external memories, an 8-bit data bus, a 16 MHz oscillator, an open collector reset, and a watchdog timer. Three A/D-converters within the processor are used. The processor's internal UART communicates with the CPU board.

High speed I/O is used to obtain pulse control sequence necessary for pulse oximetry measurement. It gets its timing clock from the oscillator.

Temperature measurement section

Value of NTC-resistor in the probe depends on patient's temperature. It is measured with the following principle.

The temperature signal(s) is produced by voltage dividers, part of which is the patient probe (YSI 400-series thermistor). The output is amplified by the calibrated amplifier(s) whose offset voltage makes its output spread on both sides of zero. Wider output range (measurement range) means better resolution.

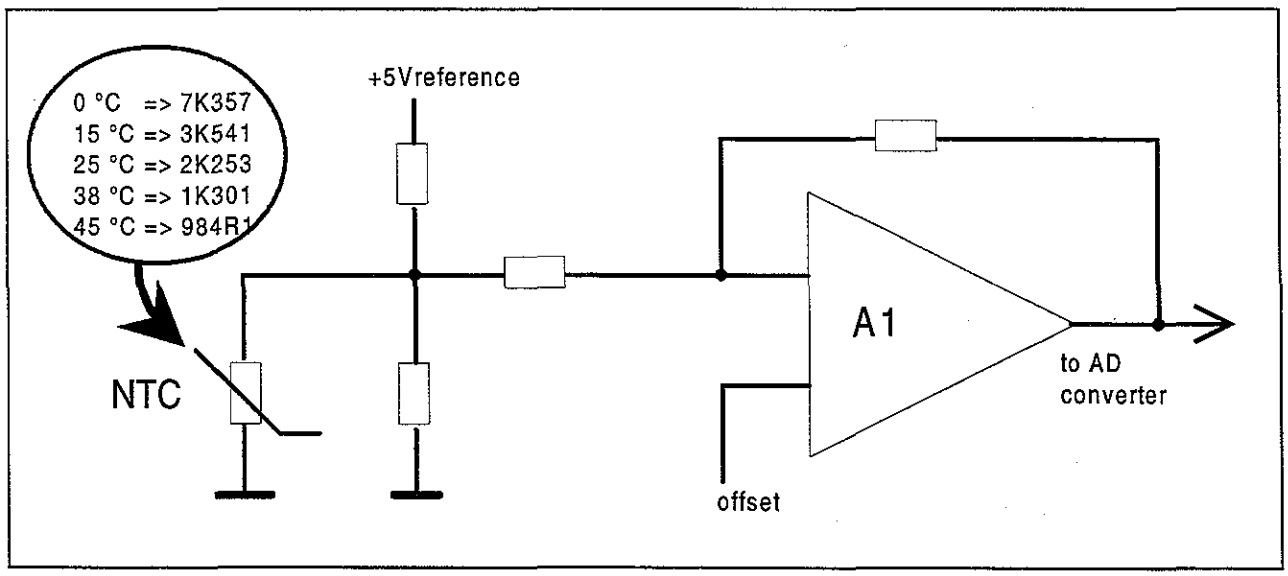


Figure 3 Temperature Measurement Block Diagram

Invasive blood pressure measurement section

Isolated +5 V voltage is supplied to the pressure transducer. From the bridge connection a differential voltage, which depends on pressure and supplied voltage, is calculated (see the formula below).

Uout = Uin x Pressure x 5 V

where Uin = 5 V

Uout = 25 V x Pressure [mmHg]

Pressure amplification is realized in the instrumentation amplifier. Gain of the amplifier is set so that the level of the signal transferred to A/D converter stays within the measurement range even when there are circumstantial offsets or offsets caused by the transducer. There is a filter before the amplifier to attenuate high frequency disturbances.

There is also FET switch, which, by cutting the measurement current, detects the existence of the transducer. The existence of the transducer cable is also checked binary by the jumper beside the connector.

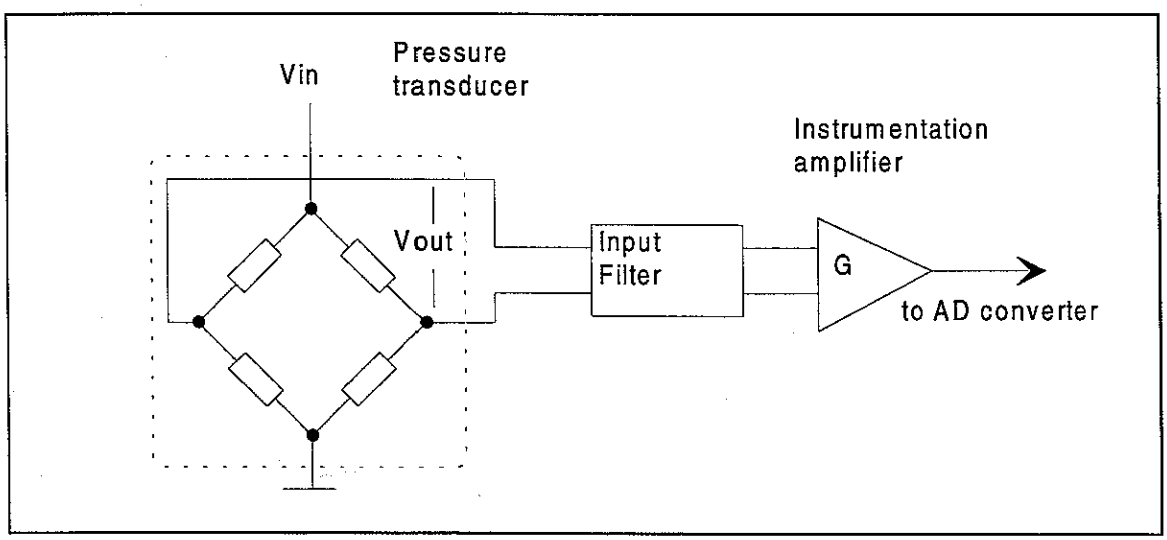


Figure 4 Pressure Transducer Working Principle

Pulse oximetry measurement section

LED control signals

The processor sends pulse width modulated signals, IRED intensity and RED intensity, which are converted to DC voltage and filtered. By switches either RED or IRED intensity is sent forward to amplifier in LED driving circuit.

LED driving circuit

Voltage difference which corresponds to LED current, is measured by the differential amplifier circuit and its output is sent back to the processor in 0 to 5 V level. There are feedback circuits from LED current measurement and LED intensity control.

Background light is measured by picking up a sample from the signal. The sample is modified to 0 to 5 V level and sent to the processor.

Measured signal preamplification

Voltage of -4 V is gained by voltage divider from -12 V and is fed to non-inverted input of current-to-voltage converter amplifier. Thus inverse bias voltage is generated for probe detection. There is a switch, which if closed, a multiple (x30) amplification is resulted (necessary in thin tissue measurement such as earlobe).

Digitally controlled amplifier

D/A converter is a digitally controlled amplifier after which there is another constant amplifier.

Red and Infrared channels' separation

Red and infrared channels are separated from each other by switches. Operational amplifier functions as a buffer and after this infrared DC signal is sent to the processor. A capacitor separates AC signal from it and the AC signal is sent to the processor after amplification. There is a switch to choose the amplification constant.

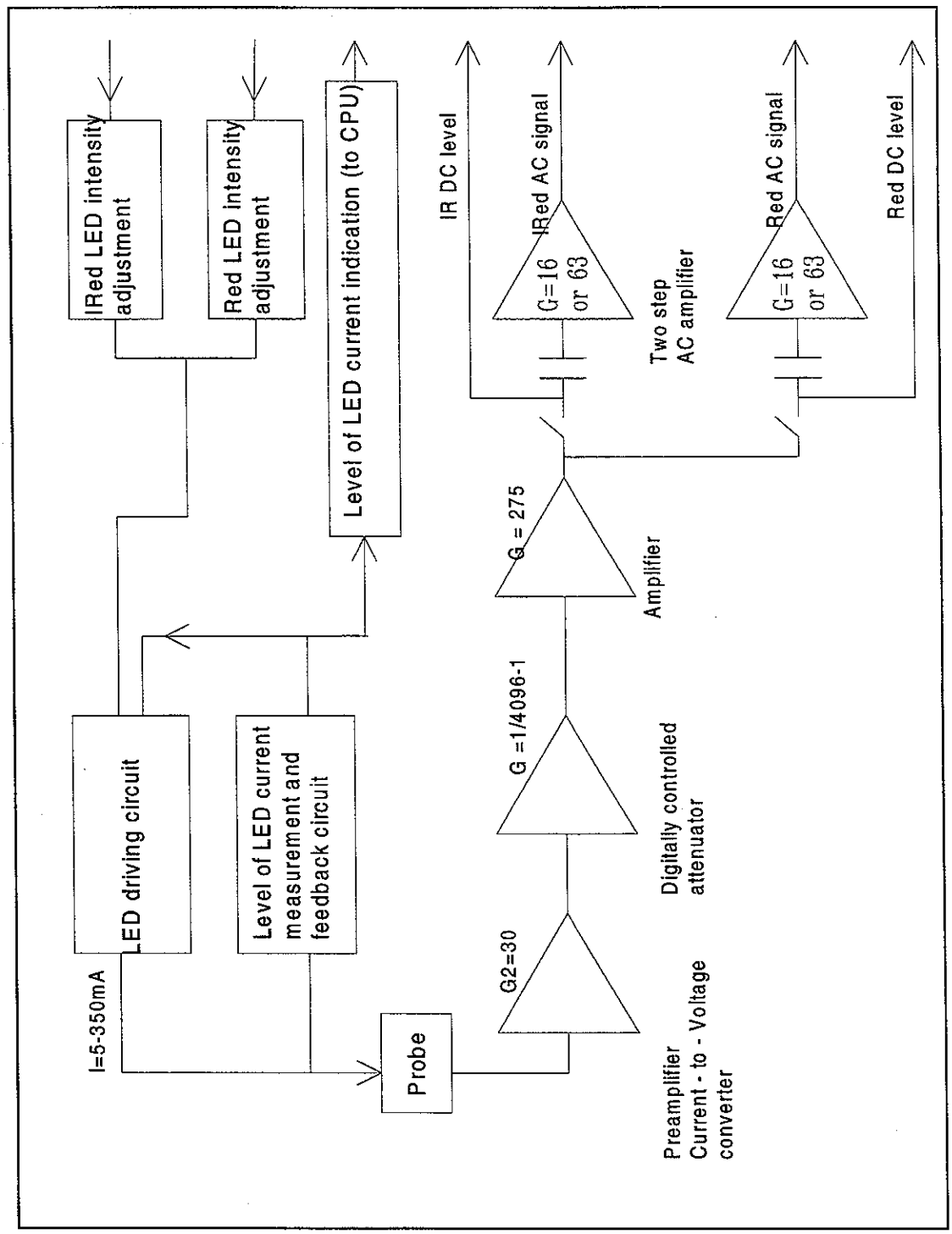


Figure 5 Pulse Oximetry Measurement Block Diagram

Serial communication

Serial communication between the module and the frame is done by RS485 type bus whose buffers get their supply voltage (+5 VDC) from the Frame and in the isolation section get the supply voltage (+5 V) from the isolated power supply.

The buffers of the serial communication are controlled also by Reset-signal so that when the Reset is active, the buffer does not transfer data.

Reset is also RS485 type and additionally, there is an auxiliary logic power reset, which keeps the reset active for about 500 ms despite the state of reset in the module bus. Time constant determines the power-up reset time. There are components to prevent the module from sending data during reset.

Data transmission rate is 500 kbit/s.

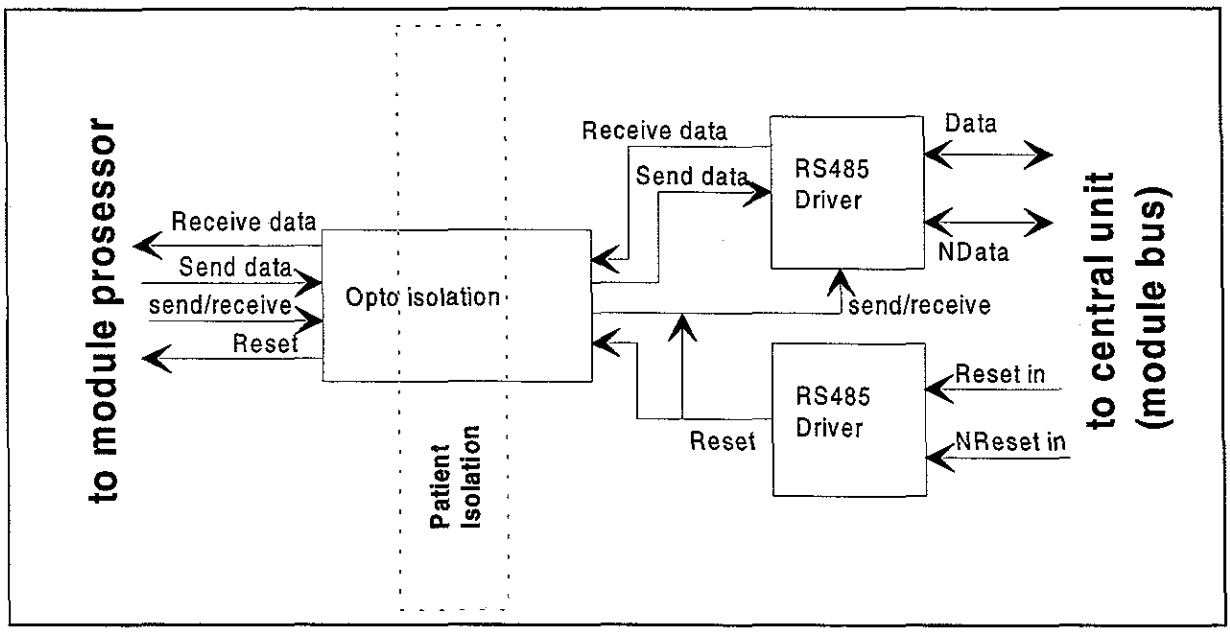


Figure 6 Serial Communication and Opto Isolation

Isolated section

There are two opto isolators. Signal is processed on logical high-low level even though the outputs of the opto isolators are analog signals in the isolated section.

Reset line is an open collector type with a pull-up resistor. Thus the processor is able to use its internal watch-dog function.

Power supply section

Isolated supply voltage of the module is developed from +15 Vdirty voltage from the Central Unit. Power supply is a switched-mode circuit, where FET transistor switch is controlled by an oscillator using bipolar timer. The frequency of the oscillator is about 30 kHz and pulse ratio 50 %. Controlling of the FET switch is slowed to suppress spurious interference.

A special pulse transformer is used in the circuit. In the secondary circuit normal linear regulators are used except for +5 V (low drop type linear regulator).

Input:
+15 Vdirty = +15 V $\pm$0.5 V; 0.3 A

Isolated outputs:
+5 Vref = +5 V $\pm$0.1 V; 100 mA max
+5 V = +5 V $\pm$0.2 V; 100 mA max
+12 V = +12 V $\pm$0.3 V; 70 mA max
-12 V = -12 V $\pm$0.3 V; 70 mA max
-5 V = -5 V $\pm$0.2 V; 20 mA max (STP board only)

Total power:
About 3.5 W
All the voltages are regulated. Isolation primary/secondary 5 kV.

Test points:

There are test pin blocks identical both in STP and ECG boards. Pins and voltages are as follows:

Voltages

X11	pin 1	+5 Vref
	pin 2	+5 V
	pin 3	+12 V
	pin 4	Gnd
	pin 5	-12 V
X12	pin 1	-5 V (STP board only)

2.2.2 ECG Board

Patient signals are connected to overload protection circuits (resistors and gas-filled surge arresters) and analog switches to instrumentation amplifiers. Then the signals are amplified by 480 and limited by slew rate. Then they are A/D-converted, analyzed and transferred to module bus in digital form.

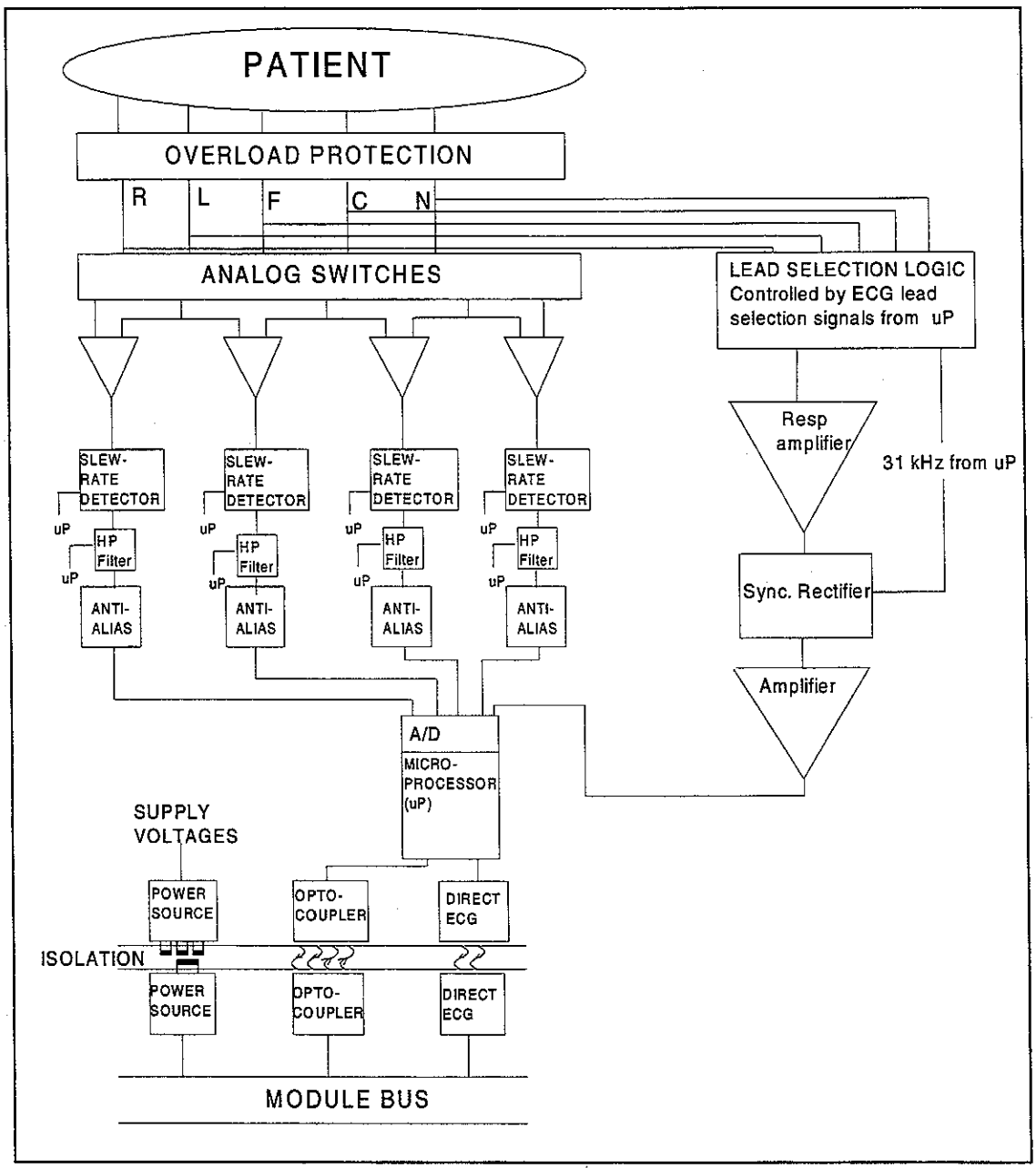


Figure 7 ECG Measurement Block Diagram

Analog ECG section

ECG cable is connected to connector pins E1 to E6 on the input board which contains an overload protection circuit.

Leads are connected to amplifiers via analog switches. State of the switches depend on the cable type.

Lead-off, noise and pacemaker are detected by a slew rate detector.

Cut-off frequency is determined in high pass (HP) filter 0.5 Hz (monitor bandwidth) or 0.05 Hz (diagnostic or ST-bandwidth).

ECG Filtering

The AS/3 monitors have three ECG filtering modes:

MONITORING	0.5 - 30 Hz (-3 dB with 50 Hz reject filter) 0.5 - 40 Hz (-3 dB with 60 Hz reject filter)
DIAGNOSTIC	0.05 - 100 Hz
ST FILTER	0.05 - 30 Hz (with 50 Hz reject filter) 0.05 - 40 Hz (with 60 Hz reject filter)

The purpose of filtering is to reduce high frequency noise and low frequency (e.g. respiratory) movement artifacts.

Monitor filter is used in normal monitoring. Diagnostic filter is used if more accurate diagnostic information is needed. ST filter gives more accurate information of ST segment, but reduces high frequency noise.

The high-pass filters 0.5 Hz and 0.05 Hz are done with hardware. The monitor sends a command to the ESTP(R) module determining which of the corner frequencies 0.5 Hz or 0.05 Hz is to be used.

The 50 Hz and 60 Hz reject filters are both low-pass (notch type) filters with zero at 50 Hz or 60 Hz correspondingly and they are done with software. They are for the mains supply filtering. When notch filters are used, 3 dB value for low-pass filter is 30 Hz or 40 Hz.

In diagnostic mode software (notch) filters are not used. Then the upper frequency is limited by hardware and the 3 dB frequency is 100 Hz.

Respiration section

The analog switches control the current supply source of the impedance respiration measurement, and the lead selection for the 3-lead cable can be seen from the following table:

Selected lead	Current source between	Signal measured from
I	R - L	N
II	R - N	L
III	L - N	R

When the 5-lead cable is used, the current source is between L-F and the signal is measured from the N, independently on the lead selection.

The respiration amplifier consist of the operational amplifiers, and the components around them. There is a analog switch for controlling the gain of the first stage of the preamplifier.

Synchronous rectifier consist of the analog switches, which are used for detecting the respiration signal from 31 kHz amplitude modulated raw signal.

The amplifier stage consist of the differential amplifier and the last amplifier. The differential amplifier consist of the operational amplifiers and the components around them. This stage is AC-coupled on both sides for minimising the offset voltages.

The last amplifier is used for amplifying the signal derived from differential amplifier stage.

The respiration signal is zeroed at the beginning of the measurement. Zeroing is also used for fast recovering the measurement after the motion artefact. This is done in amplifier section.

Microprocessor section

Microprocessor contains RAM and EPROM memories. The processor uses external EEPROM memory. The microprocessor's internal 8-channel A/D-converter converts the ECG-signals to digital form.

Serial communication

Communication with the module bus is made through RXD and TXD pins. See the serial communication section in STP board description.

Isolated section

The patient isolation of ECG is 5 kV in M-ESTPR rev. 01 and M-ESTR/ETPR rev. 01 modules.
NOTE: The isolation has been changed from the earlier revisions.

WARNING: Do not touch battery operated monitor during defibrillation procedure.

See the isolated section in STP board description.

Power supply section

See the power supply section in STP board description.

There is a test connector (x20) on the board for voltages + 5 VREF, +5V, +12V, GND and -12V.

2.2.3 Module Bus Connector Configuration

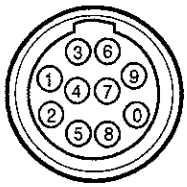
Rear panel 25-pin female D-connector (X1)

Pin No	I/O	Signal
1	I	RESET_RS485*
2	I	-15 VDC
3	I	+15 VDIRTY*
4	I	+15 VDC
5	I/O	-DATA_RS485*
6	I/O	DATA_RS485*
7		Ground & Shield*
8	I	-RESET_RS485*
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13		Ground & Shield*
14	I	+32 VDIRTY
15	I	GroundDIRTY*
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20		ON/STANDBY
21	O	PWM_ECG
22		RXDD_RS232
23		TXDD_RS232
24	I	+5 VDC*
25	I	+5 VDC*

*** Used in the ESTPR, ESTR, and ETPR modules**

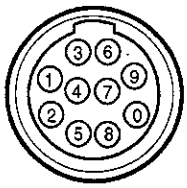
2.2.4 Front Panel Connectors

The pin assignment on the ECG connectors



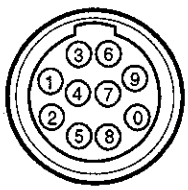
Pin No	Signal
1	Right arm electrode (R)
2	Left arm electrode (L)
3	Right leg electrode (RL)
4	Left leg electrode (F)
5	Chest electrode (C)
6	Cable shield
7	Not connected
8	3/5 lead identification
9	Lead connection check
0	Ground

The pin assignment on the SpO2 Connector:



Pin No	Signal
1	Feedback resistor
2	Ground
3	Not Connected
4	Cable shield + probe identification ground
5	Probe identification
6	LED drive ground
7	LED drive current
8	Input signal current
9	Ground
0	Ground

The pin assignment on the Invasive pressure connector:



Pin No	Signal
1	Pressure +
2	Pressure -
3	Polarisation - (ground)
4	Polarisation +
5	Not connected
6	Not connected
7	Not connected
8	Not connected
9	Ground
0	Cable detection

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

CAUTION: Only trained personnel with appropriate equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Preventive Maintenance

Perform these checks after any service and at least once a year to keep the ESTPR/ESTR/ETPR Module in good condition.

1. Visual inspection

___: If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside before attaching the module box.

2. Functional checks

Module:

___: Insert the module into frame.

___: Turn the monitor on. Select SpO_2 and Temp to be shown in digit fields. Within 15 seconds, SpO2 and Temp windows should appear on the display. No error message appears.

___: Pull out the module. The SpO2 and Temp windows go blank within 15 seconds.

___: Reinsert the module while the power is still on. The SpO_2 and Temp measurement data appear on the windows again.

___: Connect a finger sensor to the module. The message Probe off should appear on the display. No waveform appears. Attach the sensor to your finger. The reading of 95 to 99 and an SpO_2 waveform should appear.

___: Go to ESTPR:ECG and ESTPR:STP/P Service Menus (Path: Monitor Setup, Install/Service (password 16-4-34), Service View (password 26-23-8), Modules) and check the functions of cables and buttons (ON/OFF test).

ECG Cables:

___: Check the cables visually, and replace if any damages appear.

To test the cable:

___: Check that the following resistances are 4-6 kohm:

Clip to	ECG connector pin
N/RL	3
L/LA	2
R/RA	1
F/LL	4
C/V	5

___: Check that the resistance from a lead to other leads and to the shield (pin no 6) is > 1 Mohm.

If any of the tests fail, replace the cable.

ECG Cables together with Module:

___: Choose a field for ECG waveform (ECG1) in Monitor setup menu. The text 'Leads off' appears. Connect simulator to the module. The heart rate reading appears and the heart symbol starts to blink within 15 seconds. No error messages appear. Press the ECG LEAD key and try all Lead selections.

___: To test all the leads perform following tests:

1. Connect a 3-lead cable to the module.
2. Connect the leads together (e.g. to a screw driver).
3. Select one lead for display.
4. Detach a lead from the screw driver, and see that the module responds as described in the table. Connect the lead again.

Lead selection	**Lead to be detached**	**What appears on the screen**
Lead I	L/LA	L/LA Off
	R/RA	R/RA Off
	F/LL	Leads off
Lead II	L/LA	Leads off
	R/RA	R/RA Off
	F/LL	F/LL Off
Lead III	L/LA	L/LA Off
	R/RA	Leads Off
	F/LL	F/LL Off

Temperature:

___: Put a temperature test plug into T1 and T2 and make sure that the measured values do not deviate more than ± 0.1°C. If they do, perform the temperature calibration.

Impedance Respiration

NOTE: The procedure described for the resp check apply to the MedSim 300 patient simulator only.

___: To test impedance respiration

1. Press the **ECG Lead** key on the module. Confirm that the ECG lead selection is displayed, and changes with each key press. Then set the lead selection to Lead II.

2. Press the **Monitor Setup** key and select *Waveform Fields* to get into the corresponding menu. Make sure that the resp waveform is configured to be displayed.

3. Adjust the patient simulator as follows.

* Lead selection to II/RL-LL

* Resp rate to 20

* Ohms to 1.0

4. Press the **Others** key and select *Resp Setup* to get into the corresponding menu. Set the resp rate source to impedance.

5. Press the **Normal Screen** key. Confirm that the resp waveform and the resp rate are displayed after a delay of approximately 30 seconds.

___: To test apnea detection

1. Adjust the patient simulator as follows:

* Select **resp** by pushing the F2 key of the patient simulator

* Select the **apnea** from the patient simulator menu (to get more menu push the arrow key right)

2. Select **cont** from the patient simulator menu, **APNEA** alarm should be displayed on the monitor screen after a delay of approximately 30 seconds.

3.3 Disassembly and Reassembly

Disassemble the ESTPR/ESTR/ETPR module in the following way. See Figure for the exploded view of the module.

a) Remove the two screws from the back of the module.

b) Pull the module box slowly rearwards and detach it from the main body. Be careful with loose latch and spring pin for locking.

c) Two main PC boards will appear. The ECG board is on top of the STP board. The ECG board will be detached by removing four screws one in each corner, disconnecting 9-pin ribbon cable that is connected to the STP board and 2-pin ribbon cable from the front panel. Slide the board rearward to disconnect the fixed 10-pin connector of ECG input board.

d) The STP board can be removed by detaching two screws on the solder side of the board near the front panel and disconnecting the two connectors from the SP input board. The T-input connector cables must be disconnected as well.

CAUTION: When reassembling the module, make sure that the cables are reconnected properly.

3.4 Adjustments and Calibrations

Temperature calibration

NOTE: For the temperature calibration, separate, accurate test plugs (25°C and 45°C) are needed. A test set of two plugs is available from Datex, order code 884515

Calibrate temperature when measured test values deviate more than ±0.1°C from the given value, and always after STP board replacement.

1. Go to ESTPR: STP service page (see Service Menu; Path: Monitor Setup, Install/Service (password 16-4-34), Service View (password 26-23-8), Modules).
2. Go to Calibrations page.
3. Press in the protect button at the bottom of the module and choose OFF in Protect mode. Release the button.
4. Choose Calibrate T1/Calibrate T2.
5. Insert calibration plug (25°C) into T1/T2 connector.
6. Push the ComWheel two times.
7. Insert calibration plug (45°C) into T1/T2 connector.
8. Push the ComWheel two times.
9. Press in the protect button at the bottom of the module and choose ON in Protect mode. Release the button.

Pressure calibration (M-ESTPR/ETPR)

Calibrate pressure when pressure transducer (probe) is replaced by another type, and when STP board is replaced.

1. Go to ESTPR: the STP service page (Path: Monitor Setup, Install/Service, Service View, Modules).
2. Go to Calibrations page.
3. Connect a pressure transducer with a pressure manometer to the front panel P1/P2 receptacle. Choose Calibrate P1 or Calibrate P2. Leave the transducer to room air pressure.
4. Push the ComWheel. The zeroing takes place.
5. Supply pressure of 100 mmHg to 300 mmHg to the transducer. Recommended pressure is 200 mmHg.
6. Set the pressure on the display with the ComWheel to match the pressure reading on the manometer and push the ComWheel. Tolerance of ±1 mmHg is allowed.
7. The text `calibrated' will appear on the display.

4 TROUBLESHOOTING

4.1 Troubleshooting Charts

See also the Operator's Manual for more troubleshooting procedures.

ECG

TROUBLE	CAUSE	TREATMENT
HR numerical display shows '—'	No heart rate available.	If no ECG waveform, check LEADS OFF message and connect the leads. If ECG waveform exists, check heart rate source e.g. in the ECG Setup menu behind ECG key.
Unacceptable ECG waveform	Poor electrode or poor electrode skin contact. Poor electrode condition.	Electrodes from different manufacturers are used./ Too much/little gel is used. Electrodes are dried out.
	Improper site of electrodes.	Check that electrodes are not placed over bones, active muscles, layers of fat.
	Improper skin preparation. Improper bandwidth filter.	Remove body hair. Clean attachment site carefully with alcohol. Check filter.
No ECG trace	Waveform not selected on screen.	Press the Monitor Setup key and make adjustments.
	Module not plugged in correctly.	Plug in.
Noise-message	High frequency or 50/60 Hz noise.	Isolate noise source.

InvBP

TROUBLE	CAUSE	TREATMENT
Abnormally low pressure	Transducer wrongly positioned.	Check mid-heart level and reposition transducer.
No pressure	Defective transducer.	Check transducer.
	No pressure module plugged in.	Check the module.
	No waveform selected on screen.	Check selected pressure waveforms by pressing Monitor Setup key and selecting modify waveforms. Check that pressure transducer open to patient.
	Wrong configuration setting	Check the configuration setting from the ESTPR:STP/Calibrations menu (Monitor Setup / Install/Service / Service View / Modules)
Not zeroed-message	Measurement on, channel not zeroed.	Zero the channel.
Zeroing failed-message	Unsuccessful zeroing of P1 /P2 (number field).	Possibly due to pulsating pressure waveform. Open the transducer to air and zero the channel. Offset is > 150 mmHg. Open the transducer to air and zero the channel. Defective transducer. Replace it and zero the channel.

InvBP (continued)

TROUBLE	CAUSE	TREATMENT
Calibration failed-message	Unsuccessful calibrating of P1/P2 (number field), possibly due to pulsating waveform	Turn the transducer to sphygmomanometer and try again (zeroing takes place first). Gain is beyond the limits (±20 % of the default gain). Replace the transducer.
Out of range ≤ 40 mmHg	Measurement pressure is beyond measurement range.	Check transducer level. Zero the channel.
Out of range > 320 mmHg	Measurement pressure is beyond measurement range.	Check transducer level. Zero the channel. The patient may also have high pressure.
Zero adj. > 100 mmHg	Offset when zeroing is > 100 mmHg (but < 150 mmHg) from the absolute zero of the module (with default gain).	Check transducer. The waveform may hit the top and the numeric display not shown.
Out of range	Measured pressure is beyond the internal measurement range of the module.	The waveform hits the top and the numeric display not shown. Check transducer and its level. Zero the channel.

Temp

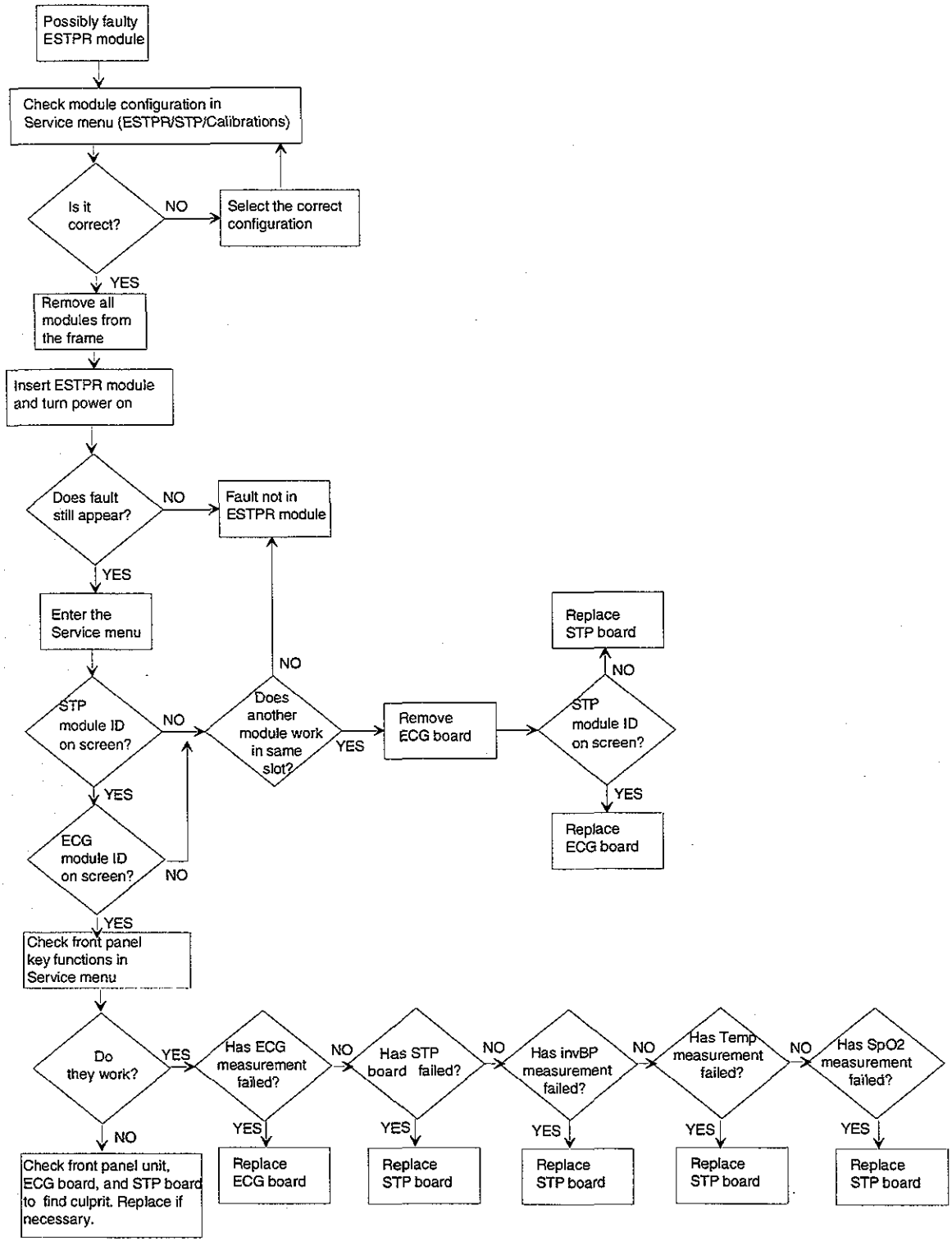
TROUBLE	CAUSE	TREATMENT
Message 'TEMPERATURE ERROR'	Faulty calibration.	Perform calibration. If it does not help, check that front panel connector is properly connected to STP board. Check front panel, SP-input board, or STP board.
No temperature displayed	Wrong type of probe. Temperature out of measurable range.	Use correct probe. The range is between 10 and 45°C. With German monitor software, check that Protection is set to ON in the Service Menu.

SpO_2

TROUBLE	CAUSE	TREATMENT
Message 'NO PROBE'	1. No probe connected to the monitor. 2. Probe faulty.	1. Check probe connections. 2. Change the probe.
Message 'PROBE OFF' though probe properly attached to the patient	1. Unsuitable site. 2. Probe faulty. 3. Probe connection cable not connected to probe.	1. Try another place. 2. Try another probe. 3. Connect the cable to probe.
Finger probe falls off	1. Probe is slippery. 2. Finger is too thin or thick.	1. Wipe with 70 % isopropyl alcohol and allow to dry. 2. Try other fingers, or other probe types.
Weak signal artifacts	1. Poor perfusion. 2. Movement artifacts. 3. Shivering.	Try another place.
Message 'NO PULSE'	Pulse search > 20 sec. and low SpO_2 or low pulse rate.	Try other fingers.
Message 'ARTIFACT'	Pulse modulation exceeds the present scale.	Try another place or another probe.
Message 'CHECK PROBE'	DC value not in balance.	Try another probe.
Message 'POOR SIGNAL'	Modulation (Red or Ired) < 0.25 %.	Patient may be cold.
Message 'FAULTY PROBE'	Probe is faulty.	Change the probe.
No SpO_2	No waveform selected on screen.	Check selected SpO_2 waveforms by pressing Monitor Setup key and selecting modify waveforms.
	Wrong configuration setting	Check the configuration setting from the ESTPR:STP/Calibrations menu (Monitor Setup / Install/Service / Service View / Modules)

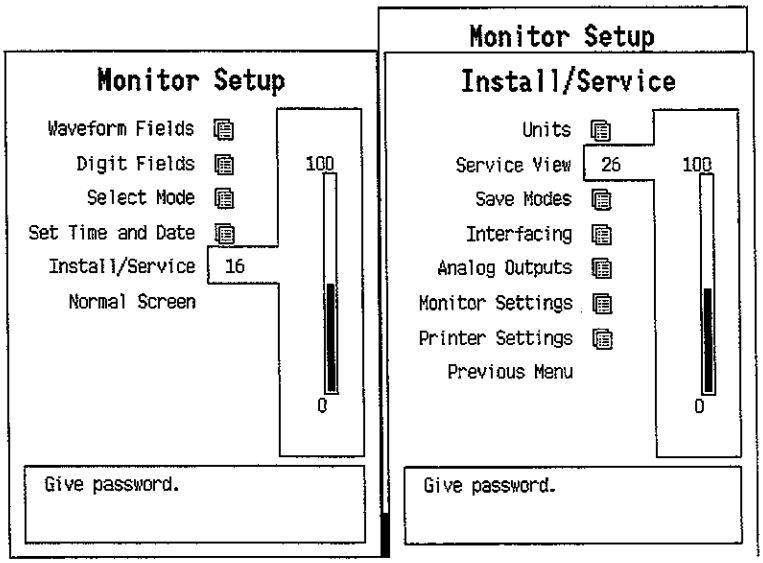
Impedance Respiration

TROUBLE	CAUSE	TREATMENT
No resp trace	Waveform not selected on the screen	Press the Monitor Setup key and make adjustments
	Module not plugged in correctly	Plug in
Unacceptable resp waveform	Poor electrode or poor electrode skin contact	Electrodes from different manufacturers are used. Too much/little gel is used.
	Poor electrode condition	Electrodes are dried out.
	Improper site of electrodes	Check that electrodes are not placed over bones, active muscles, layers of fat.
	Improper skin preparation	Remove body hair. Clean attachment site carefully with alcohol.
Message: SMALL RESP CURVE	Respiration signal is very small	With 3-lead cable try another lead connection I, II, III or try 5-lead cable.
Message: APNEA ALARM, and respiration waveform normal	Respiration source is CO_2	Check respiration source and change it to correct one.



ESTPR Module Troubleshooting Chart

5 SERVICE MENU



To enter Service Menu during normal operation:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.

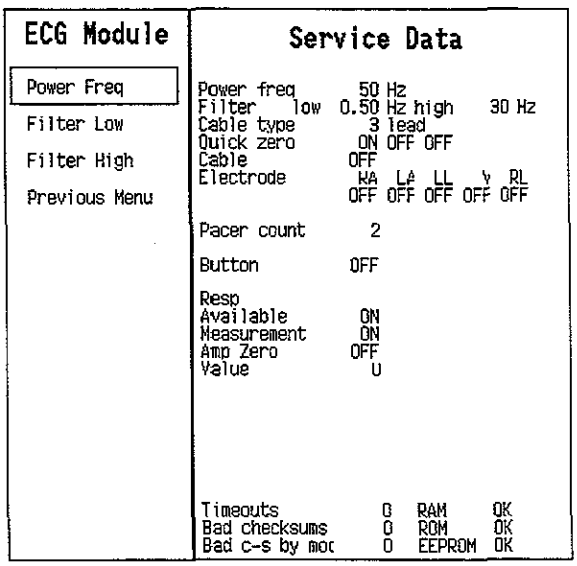
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Modules and push.

7. Turn the ComWheel to highlight the right module and push.

5.1 ECG Service Menu



1. Set power frequency (50 Hz/60 Hz).
2. Set filter low frequency (0.05 Hz/0.5 Hz).
3. Set filter high frequency
   (30 Hz (40 Hz if power freq is 60 Hz) /100 Hz).
4. Return to previous menu.

SERVICE DATA Detailed Description

Power freq, and Cable type show the values chosen or detected, **Filter low and high** defines the selected filter (Monitor/Diagnostic/ST).

Quick zero is ON when the signal in any of the three internal amplifier goes beyond scale, and therefore, a capacitor connected to the related channel discharges overvoltage. At least one of **Quick zero** values is OFF when 3-lead cable is used. All three values are OFF when 5-lead cable is used. **Quick zero** also takes place when lead is changed in 3-lead measurement.

Cable shows ON when an ECG cable is connected.

Electrode shows ON when each of these electrodes are connected.

Pacer count is a running number for pacemaker users.

The front panel ECG key function is confirmed by pressing the key and observing OFF turns to ON at **Button**.

Resp Available indicates that ECG hardware is capable of measuring impedance respiration.

Measurement shows ON when the respriration measurement is on.

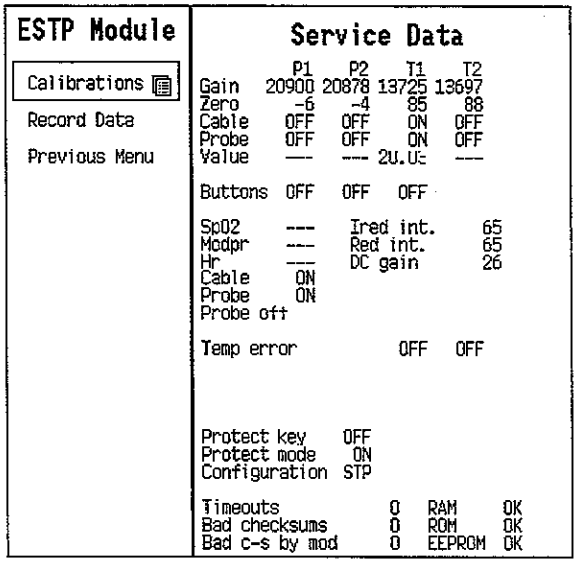
Amp zero shows ON when zeroing of the respiration amplifier takes place.

Waveform **VALUE** will be updated in one second interval.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. **Bad checksums** is a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per minute) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the external RAM memory.
ROM indicates whether the checksum at the EPROM is in accordance with the one the software has calculated.
EEPROM indicates if the values stored in the permanent memory are valid.
The state is either **OK, Fail** or **?** (module not in place or a communication error).

5.2 STP Service Menu



1. Enter calibration menu

2. Record Data prints out the service data and board information (id, serial number and sw id)

2. Return to previous menu

SERVICE DATA Detailed Description

Gain is a coefficient to compensate gain error. Usually the values for P1 and P2 are between 17000 and 25000 and for T1 and T2 between 13000 and 14300. **Zero** indicates offset compensation value of each parameter in A/D converter. Typically the values for P1 and P2 are within ±1000 and for T1 and T2 between -150 and +300. Calibrate if zero and/or gain value is outside the ranges.

Cable shows ON when a corresponding cable is connected to the front panel and **Probe** shows ON when a corresponding probe is connected to the cable.

Under **Value** the measured numeric values are displayed simultaneously. Pressure values are real time values and shown in mmHg. Temperature values are shown in Centigrade.

SpO_2 shows measured beat-to-beat SpO_2 value. **Modpr** is a modulation % that indicates DC/AC ratio in the measured signal. **Hr** is a pulse rate calculated from every beat.

Cable and **Probe** can be either OFF or ON, and these indicate the state PROBE OFF.
Under them there is a message field for SpO_2. It can OK, PULSE SEARCH, NO PROBE, PROBE OFF, NO PULSE, ARTEFACT, POOR SIGNAL, or CHECK PROBE.

Balance between leds adjusted by the modules could be done by changing the intensity of red/infrared. Intensity of infrared (**Ired int.**) is in the range of 40..255 and red intensity (**red int.**)is in the range of 40..255.

DC gain shows the gain of DC signal adjusted by the module.

The front panel STP keys functions are confirmed by pressing each key and observing OFF turns to ON at **Button**.

Temp error shows the status of the temperature test. No erros found shows the status (OFF) and errors found (ON).

Protect key shows normally OFF but turns to ON when the button at the bottom of the module is pressed.

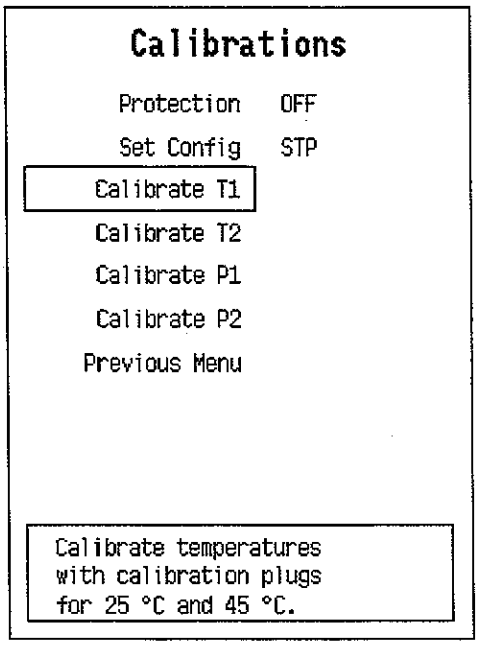
Protect mode is normally ON. It turns to OFF when Protect is switched to OFF for the temperature calibration in Calibration Menu.
Configuration shows the chosen module configuration: TP, ST, or STP.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. **Bad checksums** is a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50

per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the external RAM memory.
ROM indicates whether the checksum at the EPROM is in accordance with the one the software has calculated.
EEPROM indicates if the values stored in the permanent memory are valid.
The state is either **OK, Fail** or **?** (module not in place or a communication error).

5.2.1 Calibration Menu



Protection can be set to ON or OFF only when protect button at the bottom of the module is pressed. **Set Config, Calibrate T1,** and **Calibrate T2** selections are available only when protect mode is off. **Calibrate P1** and **Calibrate P2** are available when pressure transducer is connected to the receptacle on the front panel.

For calibration instructions, please see Chapter 3.4 Adjustments and Calibrations.

6 SPARE PARTS

6.1 Spare Parts List

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

M-ESTP Rev. 01, M-ETP Rev. 00, M-EST Rev. 00

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 01), M-P (Rev. 00-01)	*880339
7	ECG board, M-ESTP (Rev. 01)	*880338
4	Front panel unit, M-ESTP (Rev. 01)	880337
4	Front panel unit, M-ETP (Rev. 00)	880941
4	Front panel unit, M-EST (Rev. 00)	880946
	Membrane keypad	879374
10	Front panel sticker, M-ESTP (Rev. 01) (Eng)	879481
10	Front panel sticker, M-ESTP (Rev. 01) (Fre)	880158
10	Front panel sticker, M-ESTP (Rev. 01) (Ger)	880552
10	Front panel sticker, M-ETP (Rev. 00) (Eng)	880428
10	Front panel sticker, M-ETP (Rev. 00) (Fre)	880429
10	Front panel sticker, M-ETP (Rev. 00) (Ger)	880560
10	Front panel sticker, M-EST (Rev. 00) (Eng)	880138
10	Front panel sticker, M-EST (Rev. 00) (Fre)	880140
10	Front panel sticker, M-EST (Rev. 00) (Ger)	880453
1	Module box (wide)	886168
3	Latch	879181
2	Spring pin	879182
11	Metal frame	879184
5	Cross recess screw M3x8 black	616215
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700

M-ESTP Rev. 02, M-ETP Rev. 01, M-EST Rev. 01

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 02)	*(882130) Use 882627 [1] 883367
7	ECG board, M-ESTP (Rev. 02)	*(882025) Use 886748 [2] 883806
4	Front panel unit, M-ESTP (Rev. 02-03)	882127
4	Front panel unit, M-ETP (Rev. 01-02)	882128
4	Front panel unit, M-EST (Rev. 01-02)	882129
15	T-input board, M-ESTP (Rev. 02-03)	*882090
10	Front panel sticker, M-ESTP (Rev. 02-03) (Eng)	881953
10	Front panel sticker, M-ESTP (Rev. 02-03) (Fre)	881954
10	Front panel sticker, M-ESTP (Rev. 02-03) (Ger)	881955
10	Front panel sticker, M-ETP (Rev. 01-02) (Eng)	881956
10	Front panel sticker, M-ETP (Rev. 01-02) (Fre)	881957
10	Front panel sticker, M-ETP (Rev. 01-02) (Ger)	881958
10	Front panel sticker, M-EST (Rev. 01-02) (Eng)	881959
10	Front panel sticker, M-EST (Rev. 01-02) (Fre)	881960
10	Front panel sticker, M-EST (Rev. 01-02) (Ger)	881961

M-ESTP Rev. 03, M-ETP Rev. 02, M-EST Rev. 02

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 03-04), M-P (Rev. 02)	*882627
D4	STP software	*883367
	EMC plate	884099
7	ECG board, M-ESTP (Rev. 03)	*(883119) Use 886748 [2] 883806
10	Front panel sticker, M-ESTP (Rev. 03-04) (Spa)	884200
10	Front panel sticker, M-ESTP (Rev. 03-04) (Swe)	885857
10	Front panel sticker, M-ESTP (Rev. 03-04) (Dut)	886044
10	Front panel sticker, M-ESTP (Rev. 03-04) (Ita)	886753
10	Front panel sticker, M-ETP (Rev. 02-03) (Spa)	885043
10	Front panel sticker, M-ETP (Rev. 02-03) (Swe)	885856
10	Front panel sticker, M-ETP (Rev. 02-03) (Dut)	886046
10	Front panel sticker, M-ETP (Rev. 02-03) (Ita)	886754
10	Front panel sticker, M-EST (Rev. 02-03) (Spa)	885044
10	Front panel sticker, M-EST (Rev. 02-03) (Swe)	885859
10	Front panel sticker, M-EST (Rev. 02-03) (Dut)	886045
10	Front panel sticker, M-EST (Rev. 02-03) (Ita)	886755

M-ESTP Rev. 04, M-ETP Rev. 03, M-EST Rev. 03

Item	Item description	Order No.
7	ECG board, M-ESTP (Rev. 04)	*886748
	ECG software	*883806
4	Front panel unit, M-ESTP (Rev. 04)	887153
4	Front panel unit, M-ETP (Rev. 03)	887154
4	Front panel unit, M-EST (Rev. 03)	887155
15	T-input connectors, M-ESTP (Rev. 04)	*887152
16	EMC cover	884099

A front panel unit includes all the connectors and input boards.

* = the part is recommended for stock

[1] **NOTE:** The STP board 882627 can be used as a replacement only with STP software 883367.

[2] **NOTE:** The ECG board 886478 can be used as a replacement only with ECG software 883806

M-ESTPR Rev. 01, M-ETPR Rev. 01, M-ESTR Rev. 01

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 03-04), M-P (Rev. 02)	*882627
16	EMC cover	884099
7	ECG/RESP board, M-ESTPR (Rev. 01)	*884609
17	EMC cover	886818
4	Front panel unit, M-ESTPR (Rev. 01)	887153
4	Front panel unit, M-ETPR (Rev. 01)	887154
4	Front panel unit, M-ESTR (Rev. 01)	887155
	Membrane keypad	879374
15	T-input connectors, M-ESTP (Rev. 04)	*887152
10	Front panel sticker, M-ESTPR (Rev. 01) (Eng)	886603
10	Front panel sticker, M-ESTPR (Rev. 01) (Ger)	886966
10	Front panel sticker, M-ESTPR (Rev. 01) (Fre)	886963
10	Front panel sticker, M-ESTPR (Rev. 01) (Esp)	886943
10	Front panel sticker, M-ESTPR (Rev. 01) (Swe)	886928
10	Front panel sticker, M-ESTPR (Rev. 01) (Dut)	886937
10	Front panel sticker, M-ESTPR (Rev. 01) (Ita)	886925
10	Front panel sticker, M-ESTPR (Rev. 01) (Fin)	888868

10	Front panel sticker, M-ETPR (Rev. 01) (Eng)	886604
10	Front panel sticker, M-ETPR (Rev. 01) (Ger)	886967
10	Front panel sticker, M-ETPR (Rev. 01) (Fre)	886965
10	Front panel sticker, M-ETPR (Rev. 01) (Esp)	886944
10	Front panel sticker, M-ETPR (Rev. 01) (Swe)	886929
10	Front panel sticker, M-ETPR (Rev. 01) (Dut)	886938
10	Front panel sticker, M-ETPR (Rev. 01) (Ita)	886926
10	Front panel sticker, M-ETPR (Rev. 01) (Fin)	888869
10	Front panel sticker, M-ESTR (Rev. 01) (Eng)	886605
10	Front panel sticker, M-ESTR (Rev. 01) (Ger)	886968
10	Front panel sticker, M-ESTR (Rev. 01) (Fre)	886964
10	Front panel sticker, M-ESTR (Rev. 01) (Esp)	886945
10	Front panel sticker, M-ESTR (Rev. 01) (Swe)	886930
10	Front panel sticker, M-ESTR (Rev. 01) (Dut)	886939
10	Front panel sticker, M-ESTR (Rev. 01) (Ita)	886927
10	Front panel sticker, M-ESTR (Rev. 01) (Fin)	888870
1	Module box (wide)	886168
3	Latch	879181
2	Spring pin	879182
11	Metal frame	879183
5	Cross recess screw M3x8 black	616215
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700

A front panel unit includes all the connectors and input boards.

* = the part is recommended for stock

6.2 Exploded View

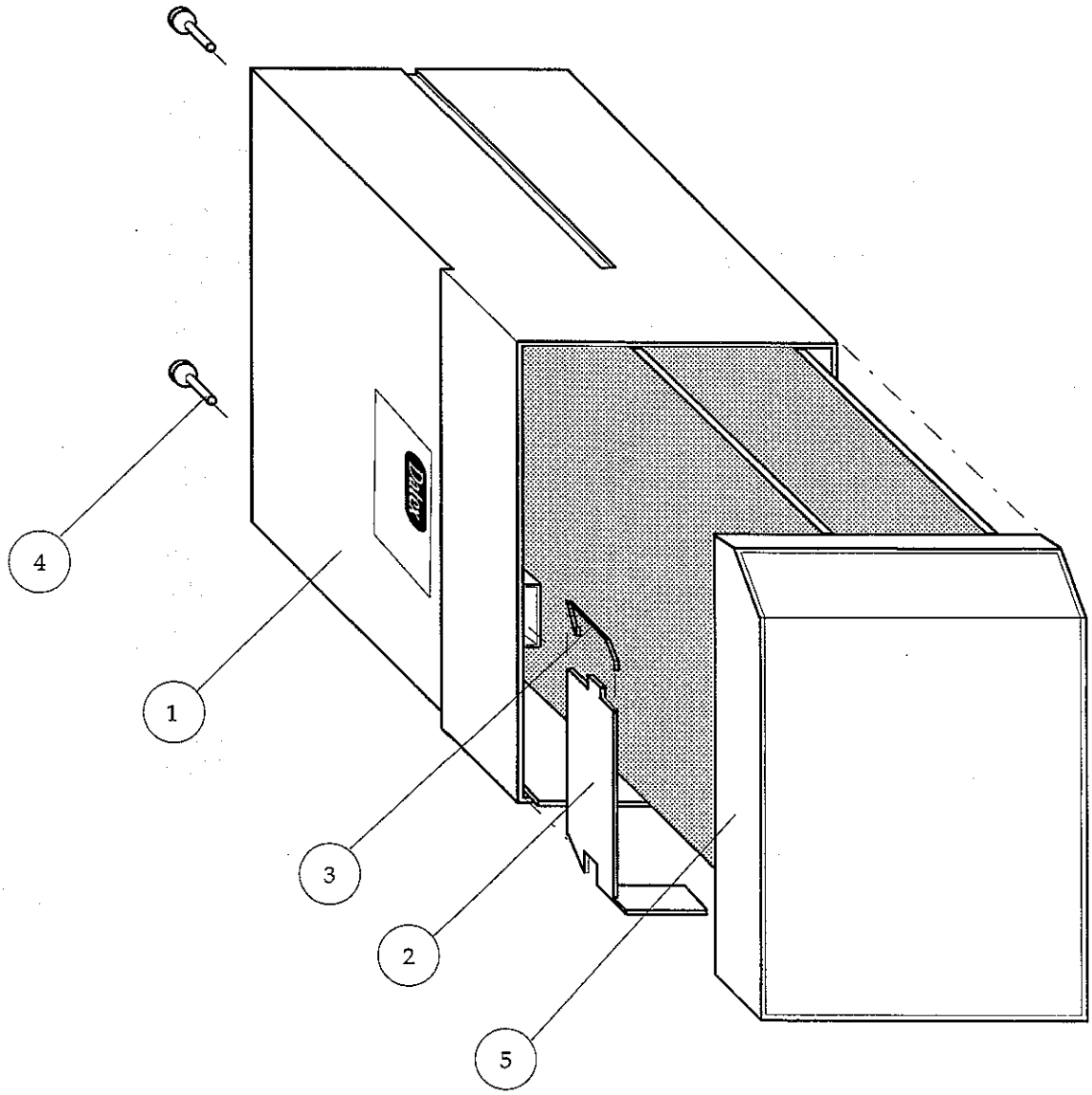


Figure 8 Exploded View of Module Box

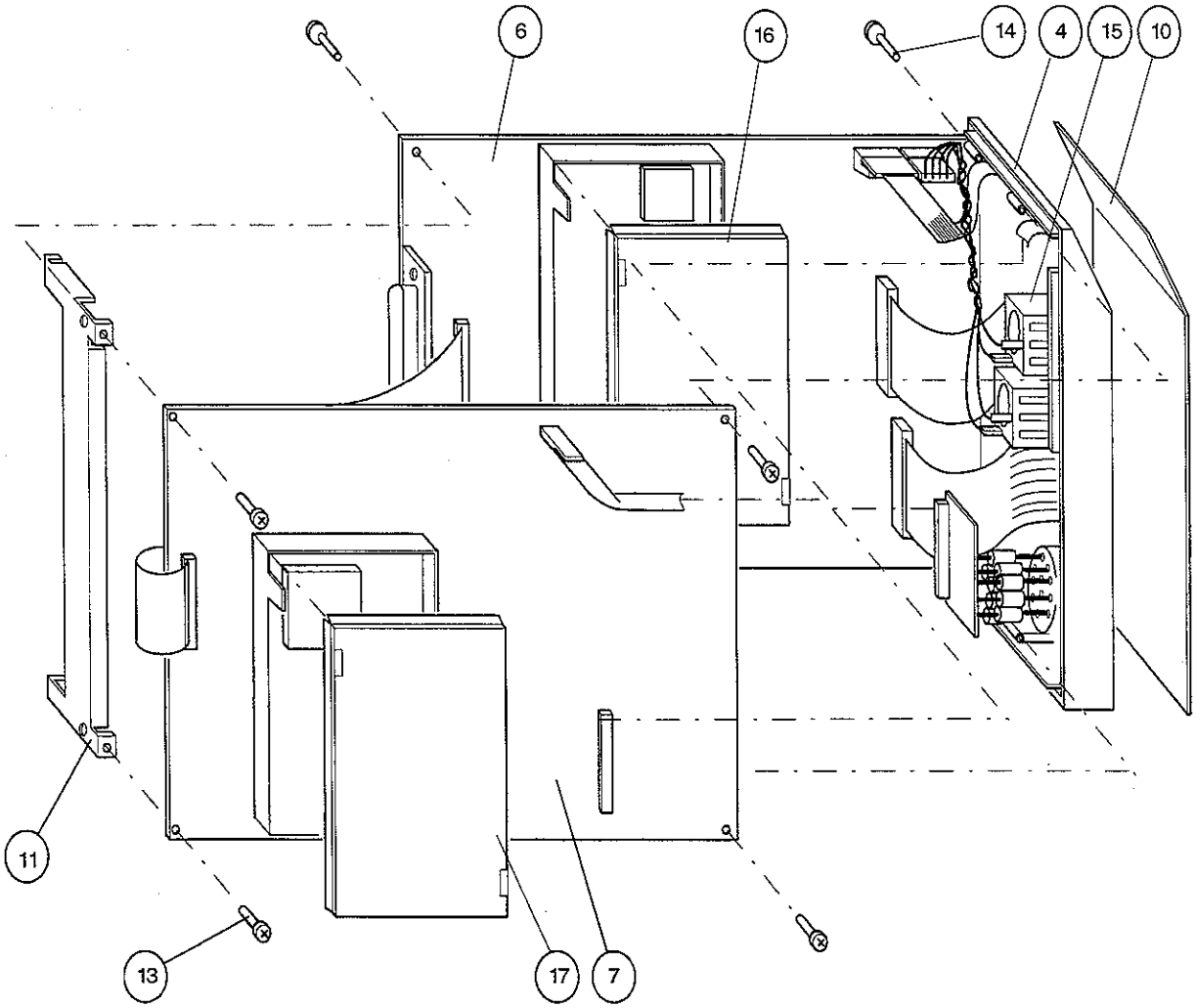


Figure 9 Exploded View of Module

7 EARLIER REVISIONS

For service information on the earlier revisions, please refer to:

ESTP Module revision 01	Service Manual p/n 880850
ETP Module revision 00	-"-
ESTP Module revision 02	Service Manual p/n 882580
ETP and EST Modules revision 01	-"-

ESTP Module revision 03-04, and ETP and EST Modules revision 02-03 are supported by this manual too.